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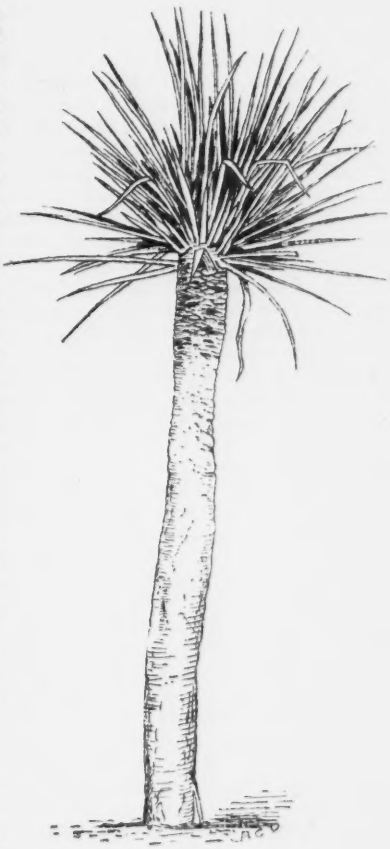
## THE DRAGON-TREE OF TENERIFE.

By R. Camper Day.

THE belief of the Greeks and Romans that somewhere beyond the Straits of Gibraltar, in the perilous and mysterious Atlantic, lay the beautiful islands of the Hesperides, where a dragon kept watch over a tree bearing apples of gold, was to some extent justified by a slender substratum of truth. For in the Atlantic, not so very far from Gibraltar, is to be found the little cluster of the Canary Islands, containing no dragon indeed, but a very wonderful tree, whose fruit is the size of a dwarf apple, and resembles red gold in colour. This tree is known as the dragon-tree, or *Dracæna draco*, and it lives to a greater age than any other plant.

The Canaries have often been called the Pleiades of the Atlantic, a constellation of seven small islands. It is perhaps more appropriate to compare them to a planet attended by six satellites, one of them, the island of Tenerife, being considerably more massive than the rest, as well as more interesting. The wonders that meet the eye of a visitor to this island are innumerable. The greatest and most overpowering is of course the huge quiescent volcano, crowned by the well-known peak, and covering with its irregular base the whole area of the island. The outline of the island is not unlike the side view of a boot, with the toe pointing north-east and the sole turned towards the north-west; and the Peak of Tenerife is situated exactly at the ankle. The total length of the island is sixty miles, and from every part of the coast-line the ground rises steadily, though with many ups and downs in some places, to the summit of the cone. The cone itself, a comparatively recent formation, stands in the middle of an ancient crater no less than eight miles in diameter. In ascending the volcano the visitor finds that the average slope of the sides upwards from the sea to the edge of this crater is by no means steep. The angle is not more, on the whole, than 12 degrees from the horizontal; but on reaching the edge he comes upon an almost precipitous descent of 1,800 feet into the great basin. As he traverses the basin towards the central cone, high above the level of the clouds, exposed to sunshine of tropical intensity, and winds of piercing chilliness, he passes the ice-cavern which so enchanted Humboldt, and although the volcano is classed as inactive, he comes to many a vent puffing out whiffs of volcanic breath, and many a place where the ground is almost too hot for his feet. If, then, the visitor to Tenerife is a geologist, he will find in the volcano itself enough to occupy his whole attention. If he is a botanist, he will have ample employment in studying the five distinct zones of vegetation that clothe the sides of the mountain, and if an anthropologist, in hunting for traces of that curious extinct nation, the Guanches, who embalmed their dead like the Egyptians. But whatever may be his particular hobby, or even if he has none, he can hardly fail to be interested in the singular natural product, indigenous to the seaboard of the island, known as the dragon tree.



Drawing of Young Dragon Tree at Kew.

This extraordinary creature, which has been the theme of so many enthusiastic writers from the days of Captain Glas, is distinguished by a host of interesting characteristics. In the first place, there exudes from the crevices of the stem an astringent resin of a deep red colour, formerly used as a medicine and a dye, and called "dragon's blood" by the mediæval alchemists. Magic properties have been attributed to this substance. As recently as the last century, it is said, the Devonshire girls, on being crossed in love, would cast on the fire a little packet of the red powder, and repeat the words,

> May he no pleasure or profit see,
> Till he again comes back to me.

But the resin is yielded in such small quantities that the supply for commercial purposes was unequal to the demand. As a dye it has consequently been superseded by the cochineal insect and the coal-tar colours, and as a drug by the produce of the rattan palm. A second peculiarity of the dragon tree is the extreme slowness of its growth; a

third is the fact mentioned above that it attains to a greater age than any other known plant. Before the year 1867 there existed in the island of Tenerife a specimen (to be presently described) which is estimated to have been at least 6,000 years old. But perhaps the most noteworthy point about the plant is that, notwithstanding its size, it cannot strictly be deemed a tree at all, but only a monstrous vegetable. While the botanists agree in classing it among the *Liliaceæ* or lily-like plants, their opinions are divided as to whether it should be called a lily proper or an asparagus, or whether it should be relegated to a separate family with the title *Dracæneæ*. On the whole, it is probable that if a census could be taken of the views of botanists a majority would be in favour of calling it a stick of asparagus.

What, then, is the dragon-tree like? Our first illustration is a portrait of an infant specimen now growing in the temperate house of the Botanical Gardens at Kew. It consists of a straight, smooth, and fleshy stem, about 7½ feet in height, variegated towards the top with scars, where old leaves have dropped off. The stem is crowned by a bunch of long and stiff leaves shaped like sword-blades, the total height from the top of the pot being 12 feet. The plant has not yet flowered, and will probably not do so for another twenty years.

After its first flowering the beginnings of branches may be expected to appear, and the tree will then enter upon the long period of middle age. In the mature tree the branches rise up like the arms of a candelabrum, and as there are no leaves except at the tips of the branches, the foliage is usually massed into a flat slab at the summit of the tree.

Any one desiring to see the dragon-tree in its old age can still find splendid specimens in the Canary Islands. There is one, for example, at Icod Alto, and another at Icod de los Viños, both of which were in existence at the time of the subjugation of the islands by the Spaniards in 1493, and one of which is mentioned in the history of the Conquest. The large illustration is a portrait of one of them. But the traveller will look in vain to-day for the great, the ancient, the phenomenal dragon tree which, prior to 1867, was to be seen at Villa de Orotava. When Tenerife was conquered, and the primitive inhabitants exterminated, this tree was already old. At the close of the fifteenth century the great stem was a landmark in the delimitation of two estates, and as such it is mentioned in ancient documents which are still preserved. The Spanish general, Alonzo del Lugo, shocked to find that the hollow trunk had been used by the aborigines for Druidical rites, converted it into a chapel for the celebration of the mass. Situated in sight of the cone of Tenerife, and possibly a witness of its formation, the primordial Dracæna was still healthy and vigorous at the opening of the present century. In 1819 a large limb (according to one account a third of the spreading top) was lopped off and other damage done by a tempest, and a huge portion of the stem was afterwards hacked away by a botanical vandal; but the tree was mended with masonry, and still there seemed to be no reason why it should not endure for many centuries more. But in 1867 there came an exceptional storm, which broke off the tree just at the point where the branches begin. Efforts were made to preserve the old dead trunk, but without success, and now not a vestige of it remains on the spot where it stood. The proprietor of the ground, however, had raised some seedlings from the old tree, and one of these, an infant of some twenty years, serves to mark the site of its venerable predecessor.

Many pictures of the tree are in existence, but with a single exception they are caricatures such as give no true idea of its habit and appearance. I have not seen the picture given in the "Atlas Pittoresque" of Baron Humboldt, but it is said to be so singularly incorrect as to represent an elm rather than a dragon tree. His sketch, it seems, was not taken on the spot, but was copied from a drawing by M. Marchais, and that from an unsatisfactory sketch by M. Ozone, which is still preserved in the hydro-

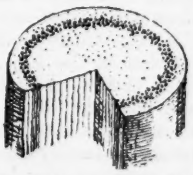
The Old Orotava Dragon-tree destroyed by a Storm in 1867.

graphical department of France, and each stage of copying seems to have been attended by a further departure from the truth. Fortunately, before the final catastrophe took place, the tree was visited by Professor C. Piazzi Smyth, Astronomer Royal for Scotland, who not only wrote an interesting and accurate account of it in his charming book about Tenerife, but earned the gratitude of all botanists by taking its photograph. It is through his courtesy that a drawing of this unique sun-picture of the oldest tree ever known is included among the illustrations to this article. The tree was certainly in luck, for in the early days of photography it was hardly to be expected that the observant eye of the camera would be opened in so remote a place.

"Sixty feet high above the ground at its southern foot," says the Professor, "forty-eight and a half in circumference at" its base, "35·6 at six feet above, and 23·8 at 14·5 feet above, or the place where the branches spring out from the rapidly narrowing conical trunk—this Dracæna cannot compare with the real monarchs of the forest for size." High up on the Sierra Nevada of California, in the county of Calaveras, there is a grove of Wellingtonias (*Sequoia gigantea*), four of which are over 300 feet in height, and our Australian colonies can show still more enormous individuals among the gum-trees. But these monarchs of the forest, mighty as are their dimensions, are centuries younger than the dragon tree of Orotava. In short, it was its wonderful vitality and its no less eminent slowness of growth rather than its pre-eminent size that made this dragon tree the wonder of the vegetable world.

"Let us take note," says Professor Piazzi Smyth, "of its chief characteristics. First, the immense uprearing of long naked root-like branches, and the pyramidal outline of the trunk. The leafage makes no very sensible appearance; there is the typical tuft at the end of each branch or rather stem; but the miniature palm-trees have been growing for ages without bifurcation, extending only in length, nothing in breadth. At the point of junction of two or more a thickening of the lower branch begins, and occasionally may be seen one or two withered radicles hanging loose, for they have failed to enter the bark, and work their way down to the ground."

When the stem of a young oak-tree is sawn across, the interior is seen to consist of a number of concentric rings, and it is well-known that the number of these rings indicates the age of the tree in years, for a new ring of wood is formed every year outside the old ones. Hence it was found possible to estimate accurately the age of the mammoth Sequoias of Calaveras; for shortly after the discovery of the grove one of the largest trees, the "father of the forest," was cut down, and a clean section made through the trunk at the height of forty feet from the ground. The number of rings, on being carefully counted by experts, was found to amount to 1,255, and to this number we must add about fifty for the time occupied by the plant in reaching the height of forty feet. The age of the tree was therefore somewhere about 1,300 years. But if the trunk of a young Dracæna be sawn across, the interior will be found to present an entirely different appearance. No concentric rings will be observed, but a uniform woody or fleshy substance, diversified (like the end of a piece of cane) by numerous little dots. For flowering plants are divided into two classes, formerly distinguished by the names Exogens and Endogens, or "outward growers" and "inward growers." These names were given because it was known that the growth of Exogens was caused by the formation of layers or rings of new wood *outside* the old wood; and it was supposed that the growth of Endogens was due to the formation of new wood in the *middle* of the trunk. This latter view has turned out to be not quite accurate, and it is now the fashion to call the two classes Monocotyledons and Dicotyledons (hard words, but necessary) instead of Endogens and Exogens. The oak and all other British trees belong to the latter; the former, to which the Dracæna and the palm-trees belong, has no larger British representative than the Butcher's Broom.



Section through the Stem of a Monocotyledon.

Now when the little dots with which the cross section of the stem of an endogen is speckled are examined under the microscope, each of them is found to consist of a bundle of minute fibres encased in a sheath. The bundle runs up through the trunk like the wick through a wax candle; and just as the wick of the candle terminates in the flame, so the bundle of fibres terminates in a leaf. The purpose of the bundle is to convey nutriment, chiefly water, from the roots of the tree to its own particular leaf. While the tree is still young the dots will be found distributed equally over the cross-section; but as it grows older the new dots seem to be produced near the bark, as shown in the following sketch. In fact it is in the zone between the bark and the interior wood (and not in the centre) that the new bundles are formed that cause the trunk to swell in size; and it is to the inextinguishable vitality of this zone that the dragon tree owes its longevity.

We have seen that after a certain period in the growth of the tree no new fibres make their appearance in the middle portion of the trunk, but it does not follow that this middle portion remains altogether unaltered. It usually undergoes a very important change: in point of fact, it dies. Hence it is that the trunk of a large dragon tree, like the patriarch of Orotava, is hollow; and hence arose the ingenious theory that an old dragon tree ought not properly to be called a single tree, but rather a community of many trees. Each of the branches is really a separate individual. The original tree is dead and gone; the only living portions of the huge fabric are the topmost branches and their fibres in the circumference of the slowly expanding hollow trunk. An old dragon tree, then, is an aggregate of individuals, each of which in some measure contributes to the support and aids the existence of the rest, just as the bees in a hive are separate individuals, all of which contribute to the support and continuance of the whole. In fact, as Professor Asa Gray has remarked, an old Dracæna is like nothing so much as a genealogical tree, the later ramifications of which alone are living.

Professor Gray, it may be mentioned, who formerly calculated the age of the Orotava tree at "perhaps hundreds of centuries," has since altered his estimate, and reduced the total to "something more than two thousand years." This estimate is certainly too low, but in the absence of concentric rings it is, of course, quite impossible to fix the age of a monocotyledon with precision. The only method open is to observe the rate at which the tree grows for a given period, and compute the age by rule of three.

It is usual for beginners in botany to learn their first lessons from our common flowers, such as the wild rose, the buttercup, and the daisy, and it cannot be doubted that this is on the whole the best course. But still there is something to be said in favour of "beginning at the other end" when an opportunity offers itself for the study of some of the stranger and rarer vegetables, such as the banyan, the bamboo, the baobab, the Rafflesia, or the Victoria regia. And it is partly with the hope of inspiring some of my readers with a liking for botany that I have ventured upon so long a description of the habit and method of growth of the dragon-tree.

## THE COMMON COCKROACH.—III.

By E. A. Butler.

THE extraordinary agility of cockroaches is matter of frequent comment with every housewife, and in consequence of their speed and the extreme slipperiness of their smooth and polished skins, they are the most exasperating of insects to endeavour to catch; while, if one tries to crush them as they run by bringing some heavy body down upon them, the blow too often descends, much to the mortification of the would-be

slaughterer, not on the insect aimed at, but upon the ground considerably in its rear. There is a fussiness and bustle about their movements which is eminently characteristic; it is not merely that much ground is covered in a short time, but also that the legs themselves are moved with remarkable rapidity; you rarely see a cockroach do anything but *run*; it hardly ever condescends to walk, and for this reason it and its associates are called the "cursorial" or running group of the order Orthoptera, while the grasshoppers, our other chief division of the order, which are distinguished by their leaping powers, and could not possibly run, are described as the "saltatorial" or leaping Orthoptera.

And yet, notwithstanding the speed of which the cockroach is capable, there is nothing exceptional in the mechanism of the movements, and the slowest crawling insect moves its six legs by precisely the same means and in precisely the same order as this most agile creature. We may, therefore, take the structure and method of use of a cockroach's legs as typical of all creeping, walking, and running insects, and there is much in them that will well repay a careful and thoughtful examination. Like those of all other insects, and of centipedes, spiders, scorpions, crabs, and lobsters, and many other allied animals, the legs are composed of a series of pieces jointed together in longitudinal order, and each piece is essentially a hollow tube, the hard and stiff walls of which give the limb its unalterable form, while they furnish support inside to the muscles by which it is moved. In some of the above animals additional firmness and strength is imparted to this hard covering by the deposition within its substance of mineral salts, especially carbonate of lime; but that is not the case with insects, the hard skin of which owes its strength and power of resistance to the animal substance chitin, which has a chemical composition represented by the formula $C_{15}H_{26}N_2O_{10}$. No greater contrast could be imagined to the vertebrate leg, with its well-nigh solid rods of bone up the centre, and its soft muscles wrapped round the outside of these, than this arthropodous (jointed-footed) limb with its hard tubular envelope, to the inside of which its soft muscular apparatus is fitted.

At the point where the leg is attached to the body the skin is soft and flexible, whereby alone any motion with regard to the body becomes possible. At this point the limb may be easily detached with a pair of scissors, and we will suppose one of the *hind* pair to have been amputated in this way. Four main divisions to the limb now become apparent (fig. 7), and in order thoroughly to understand the process of locomotion, it will be necessary to consider these divisions in some detail. First there is a stout triangular portion, by one edge of which the limb is attached to the body; it is capable chiefly of a backward and forward movement, as will become manifest by working a leg about while it is still attached to the body. This triangular basal joint is called the *coxa*, and in the cockroach is chiefly remarkable for its large size and for the great extent to which it projects from the body. Following the coxa is a longer narrower piece, flattened at the sides, and furnished with stout spines on its lower edge; this is the *femur* or thigh; it is movable upon the coxa with an up-and-down movement, *i.e.*, in a vertical plane. When the insect is viewed from above the coxæ are not seen, as they are then concealed by the body, and the legs thus appear to commence with the femora. The femur is succeeded by a longer and narrower straight piece, set with spines on both edges, which is called the *tibia* or shank; it is movable upon the femur in a vertical plane, but in the opposite direction to that of the femur upon the coxa. Finally, the leg terminates in a series of five joints, called collectively the *tarsus*, or foot, of which the one attached to the tibia is by far the longest, and the next three regularly diminish in length, but the last one is longer again, and carries at its extremity a pair of hooked claws. The joints of the tarsus are movable upon one another in the same plane as the tibia and femur, and possess at the same time the power of motion to a slight extent from side to side. These are all the parts of the leg that are obvious at a first glance, but there is still another small joint which a careful examination will detect at the outer extremity of the coxa; it is a tiny triangular piece called the *trochanter*, and has very little freedom of motion. The other two pairs of legs are similarly constituted to the hind pair, the chief differences being in the proportional length of the parts, a matter in which great uniformity is preserved in all specimens.

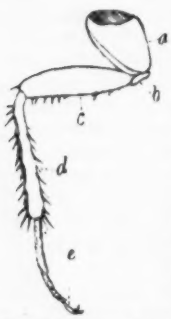



Fig. 7.—Left Hind Leg of Cockroach. *a*, coxa; *b*, trochanter; *c*, femur; *d*, tibia; *e*, tarsus.

But though the structure of all six legs is similar, the functions of the three pairs are somewhat different. In running, the first and third leg of one side are moved forward simultaneously with the middle one of the opposite side; then the other three follow for the next step, and so on. There are, therefore, never less than three legs in contact with the ground at the same time, and the tarsus is the only part that is applied to the ground, the tibia and femur being set at an angle to the tarsus and to one another. Now it is obvious that when the front leg is advanced and placed in position for a step, it is in a state of extension, the thigh being set at an obtuse angle to the shank; but the hind leg, under the same circumstances, is in a state of contraction, the thigh and shank being drawn more closely together. Therefore, when the body is advanced, the front leg is bent up and the hind leg opened out; in other words, the front leg acts in such a way as to pull the body along, the claws at the end of the feet giving secure foothold meanwhile; the hind leg, on the other hand, is not a pulling but a pushing organ, while the middle leg of the opposite side serves chiefly as a support and pivot for the body. The whole of these movements are effected by means of muscles inside the legs, each of which has one end of itself attached to one division of the leg, and the other to the succeeding one. Such, then, is the method of locomotion of the cockroach, and not only of it but of every creeping, walking, or running six-footed animal. Most swimming and jumping insects, naturally enough, however, adopt a different style, the corresponding legs of the opposite sides being moved simultaneously instead of alternately.

The digestive system of the cockroach (fig. 8) is very complete, and as there is not much difficulty in its dissection, any one may easily make out its details for himself. The only thing to be borne in mind is that all such delicate dissections as these should be performed under water, *i.e.*, the insect is fastened to a layer of solid paraffin or cork, or any other substance that will receive and hold pins readily, with which the bottom of a shallow dish has been coated, and then water is poured over it to the depth of an inch or so. Under these circumstances, when the body is opened the organs within, being buoyed up by the surrounding liquid, are displayed and rendered distinguishable to a much greater extent than would be possible in the absence of such a medium. We will suppose the insect to have been pinned down to its support in its natural position; then, on slitting open the skin along the middle of the back with a pair of

fine-pointed scissors, a mass of whitish substance is revealed, which by its extent and opacity obscures all the chief organs of the body. This is the "fat body," and must be removed before the digestive apparatus can be properly seen. It may be gently pulled out piece by piece. When this is done, the digestive system is seen to occupy the greater part of the cavity of the body, most of it being situated in the abdomen.

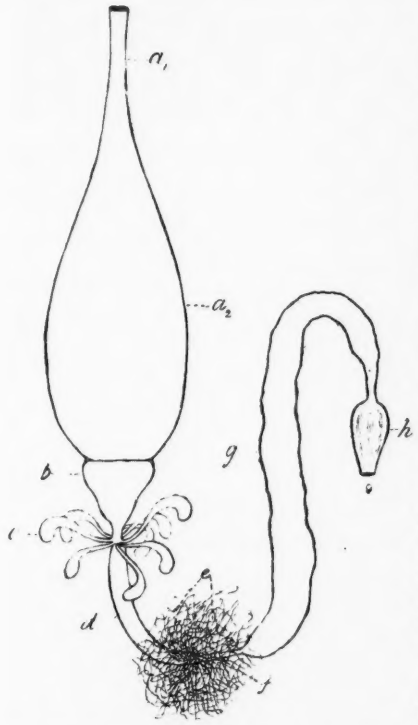



Fig. 8.—Digestive System of Cockroach. $a_1$, œsophagus; $a_2$, crop; *b*, gizzard; *c*, hepatic cæca; *d*, mesenteron; *e*, Malpighian tubules; *f*, ileum; *g*, colon; *h*, rectum.

The hinder wall of the cavity of the mouth forms a raised fleshy organ called the *lingua*, which assists in taking in the food; at the hinder end of this the throat contracts into a narrow tube, the *œsophagus*, which passes back through the thorax, and gradually expands into a capacious pear-shaped bag with thin walls, called the *crop*. So gradual is the enlargement from œsophagus to crop, that it is impossible to say where the one ends and the other begins. The crop is the receptacle which receives the multifarious objects of the cockroach's diet, after they have been roughly chewed, or rather chopped up by the mandibles. It is really of enormous size considering the dimensions of the insect, and its capacity affords a very good measurement of the voracity of its possessor. At its further extremity the crop suddenly narrows, and is immediately succeeded by another, and very much smaller pear-shaped body, set the other way round, *i.e.* with its large end foremost and narrowing behind. It has thick, muscular walls, and is furnished inside with a circle of six large chitinous prominences called teeth, as well as with little cushion-like bodies set with hairs. The whole organ is called the *gizzard*. The gizzard opens behind into a short narrow tube of about the same diameter as the œsophagus and called the *mesenteron* or mid-gut. Where this joins the gizzard, there are eight blind tubes radiating from it, tubes, *i.e.*, that are closed at their outer extremity, but open at the other end into the mesenteron. They are called *hepatic cæca* and secrete a juice which is needed in digestion, and which, when food has to be digested, is forced up into the crop and there performs that operation, the passage leading into the gizzard being meanwhile closed that no food may pass the junction till it has been suitably modified. The gizzard would seem to be not very correctly named, as it appears to act more as a strainer than as a triturator. At the end of the mesenteron, we again meet with a circle of blind tubes, but these are far more minute and far more numerous than those at its commencement. They are some sixty or more in number, and are arranged in six sets. They are so fine that they look simply like a tangle of the finest gossamer threads; individually they are very long, and twist about in all directions and amongst the other organs situated in their neighbourhood. They are called *Malpighian tubules*, and though so fine, are in reality tubes, closed at their outer end, but opening into the intestine. They are excretory in function, and appear to perform the office of kidneys. Succeeding the mesenteron, we get the intestine, which is divisible into three regions. The first is a short, narrow tube, called the *ileum*, the second a much longer and broader one, the *colon*, with loose, baggy walls, and contracted towards its hinder extremity, and the third a pear-shaped body, with its internal walls set into six prominent ridges or folds; this is called the *rectum*.

The whole alimentary canal from the commencement of the œsophagus to the end of the rectum measures about twice the length of the animal's body. All the earlier part as far as the end of the gizzard runs straight through the body without twisting; but the parts after this are more or less twisted about in order to accommodate their length and bring the rectum to the middle of the hinder end of the body, hence that portion of the canal after the gizzard needs unravelling to display its parts. In the figure it is shown in this extended condition, but in nature the rectum would be situated near to the bundles of Malpighian tubules, and the intestine would be twisted about in that neighbourhood. It is impossible in the figure to show all the windings of the Malpighian tubules; they are not merely clustered about the mesenteron as shown, but their ends are interlaced amongst the breathing tubes and the fat body and spread all over the abdomen. In all these parts they are bathed by the blood which fills all the cavities of the body, and eliminate from it the nitrogenous waste products, which thus ultimately find their way into the intestine. That part of the alimentary canal extending from the mouth to the end of the gizzard is called the *stomatodœum*, and that from the commencement of the ileum to the end of the rectum the *proctodœum*; each of these cavities was formed as a gradual growth inwards of a depression of the outer surface of the body; hence each is lined with a continuation of the chitinous skin which invests the body, and this is, therefore, renewed each time the skin is cast. The mesenteron, on the other hand, originated in a different way, and hence is not so lined. The "teeth" of the gizzard are simply extra hard portions of this chitinous lining.

(*To be continued.*)

## SKETCHES IN EVOLUTION.

By John Watson, Author of "Sylvan Folk" and "British Game Birds."

### I.—BROWN IN SUMMER, WHITE IN WINTER.

OF the protective colouring exhibited by several birds and quadrupeds in countries that remain during a greater part of the year under snow, Britain furnishes several interesting examples. Among these are the ptarmigan, variable or Alpine hare ermine, Greenland falcon, snowy owl, Lapland bunting, and other less marked instances. The very existence of each of these creatures depends upon the close-

ness with which it conforms to its environment, and just as it does this effectively, so it is robust as a species and flourishes. The inherited variability in some cases is great, and definite changes can be brought about in comparatively short periods. In other instances, however, modification is slow, and only obtained by the long process of natural selection. As an instance of the first, we have the change from dark brown to purely white of the stoat or ermine; of the second, the indigenous red grouse of the British Isles is an example. This bird is found nowhere else in a wild state. With us there is no reason why it should assume the white winter plumage like its congeners, and yet there can be no question that our bird is but the local representative of the white willow grouse, which ranges over the whole of Northern Europe. There are absolutely no structural differences between the two. Here is a species, then, which has lost through disuse the power of turning white in winter, with the absence of the necessity for doing so.

Let us see how the adaptation of protective colouring holds as applied to the species named—all of which are brown in summer, white in winter. The Iceland falcon and the ptarmigan have much the same habitat, the one preying upon the other. The ptarmigan's plumage during the breeding season is dark brown, even approaching to black; but in autumn, during the transition stage, it is grey, this being the general tint of the mosses and lichens among which it lives. Suppose, however, that the summer bird never changed its plumage, what chance of survival would it stand against its enemies when the ground was covered with snow? Remaining a black speck on the otherwise white surface, it would in a few years become extinct. The ptarmigan, then, furnishes an example of the assumption of three different states of plumage, each assimilating to the physical conditions by which it is surrounded. Of course the same rule applies to the falcon, which is also white. Precisely the same set of facts operate in the case of the large snowy owl, in the fur countries which it inhabits. Here its food consists of lemmings, Alpine hares, and birds, particularly the willow grouse and ptarmigan. The balance of nature would be slightly against it, however, in the capture of animals which have assumed protective colouring; and hence we are told that it has been known to watch grouse shooters a whole day for the purpose of sharing the spoil. On such occasions it perches on a high tree, and when a bird is shot skims down and carries it off before the sportsman can get near it. Yet, again, the same reason applies to the beautiful silver fox, which, structurally, in nowise differs from its red-furred cousin of more southern countries.

Hares, according to the altitude of their range, show almost every degree of variableness between red and white. Our common hare is widely distributed, and to such an extent do the varieties differ, that several (so called) distinct species have been evolved out of one. The extreme forms do seem widely separated until we connect them with the many intermediate links. It then becomes evident that these differences are, after all, such as may be accounted for by conditions of climate and geographical range. The northern form has thick fur, which inclines to white in winter; the central variety has fur of only moderate thickness, becoming grey in winter; and the southern, thin fur of a deep rufous tinge. The calling of these varieties "species" is simply scientific hair-splitting, though this hardly applies to the true variable or mountain hare.

This Alpine form is distributed over the countries within the Arctic circle, though with us its southern haunt is determined by Scotland and Ireland. Again, in this species we have three varietal forms, each mainly characteristic of certain latitudes. The first inhabits the warmer low-lying countries, and does not change colour in winter; of this the Irish hare is a type. The second, the variety common to northern Europe, which is grey in summer and purely white in winter; while the third is the Arctic form—white right through the year. The six types are probably all varieties of one species, which, for protection, conform to their environment; and so successfully do they do this that the progeny of two pairs of mountain hares which, in 1854 were turned down in the Faroes might long ago have been counted by thousands. The Scotch variety of this species, which does not change the colour of its fur in winter, is there called the blue hare.

Another interesting example of creatures which are brown in summer, and white in winter, is the Ermine. This is still a fairly common British fur animal, and the change may therefore be watched without going far afield. In the fur countries of high latitudes the change is universal; while here, except in unusually severe winters, it is only partial. In the Lake district, where we have observed a considerable number of these animals, a purely white one is exceedingly rare, though pied specimens are not at all uncommon. The nearest general approach to whiteness was during the prolonged severity of the winter of 1880–81. The last colour about to vanish is usually a brown stripe, prolonged posteriorly down the back; though when the weather is of extreme severity the whole transition can be brought about within a fortnight. It is not that the summer fur is cast and a new one substituted for it, but that each individual hair changes colour. Cold, artificially applied, will in time bring about the same result as a naturally severe temperature.

There arrive every year in this country from the North flocks of pretty little birds called Snow-buntings. They come from within the Arctic circle, and are so variable in their plumage that naturalists almost despaired of ever getting a characteristic description. Indeed, so great a puzzle did these little strangers offer, that for long they were described by the older naturalists as three different birds. Of course, we now know that the mountain, tawny, and snow-bunting are one; and this because we obtained them in almost every possible stage of transition. They breed upon the summits of the highest hills with the ptarmigan, and, like that bird, regulate their plumage according to the prevailing aspect of their haunt. In this they succeed admirably, and flourish accordingly.

## II.—ADAPTATION TO HAUNT.

The process of natural selection, tending to the survival of the fittest, would almost invariably seem to use colour as its main working factor. The exemplification of this law is, perhaps, nowhere better seen than in the colouring of animals and birds. In the keen struggle for existence, the creature which conforms most nearly to its environment, is the one most likely to survive, and therefore perpetuate its characteristics. For upon the fact that the peculiarities of the parents are reproduced in their offspring depends the whole theory of evolution. This may at first suggest that the generality of animals and birds closely conform to the type of the parent stock, and that, therefore, there is little chance of variation. But while this is so, it is equally true that when any sport occurs this is tenaciously retained, providing it possesses any advantages over its neighbours in the struggle for existence. In this way a new type may be set up, differing so far from the original as in time to rank as a species.

The great power of variability in animals and plants is probably not yet fully comprehended. We know, however, from Mr. Darwin's experiments how many distinct varieties

in the case of pigeons have been produced from the wild blue rock, each showing profound modification, not in colour alone, but also in bone structure. Then there are birds which show the development of hoods and frills; and others, again, which have within them the homing instinct to an almost incredible degree. All this has been brought about by man, mostly by selection, and it serves to show how pliable nature is. What has been done to pigeons applies to domestic animals. Given a few years, any monstrosity could be produced, however extravagant. Our shorthorns and blood horses have been produced out of the very sorriest material, and now stand as the idealised types of their kind; and what man does artificially, nature is doing daily, only by slow and sure methods of her own. None but those who have dipped beneath the surface can conceive of the struggle which is going on for existence. Nature's competition is of the keenest kind; the strongest survive, the weakest go to the wall. Even an object so low in the scale of animal creation as a chrysalis assumes a red coat when it is attached to a bright brick wall, and a grey one when it affixes itself to limestone. This inherited power it has in itself; and those individuals which can most cleverly practise deceit in hiding from birds and other enemies survive and reproduce their kind.

With regard to instances of variability which come under our immediate notice, the Red grouse of our moorlands is again a striking example. There can be no doubt that this is the "Willow grouse" of the Scandinavian Peninsula. Our indigenous bird found itself in an insular position, and has changed from white to speckled red, so as to conform to the colour of the heather; it has also modified the colour of its egg to suit the changed conditions of its existence. Had it remained white, it would soon have been wiped out of existence by the peregrine and other of the fiercer falcons. There can be no question that bird, animal, and insect dons the colour and form best calculated to protect it. Whether this change is conscious to the creature that practises it is beside the main question, and hardly enters the issue. The process is invariably slow; but if any "accidental sport" occurs which is likely to be of use it is tenaciously retained, and progress is made at a bound.

Many of our British birds exhibit capital instances of protective colouring, and it is a somewhat striking fact that birds of sombre plumage build open nests, while the brilliantly coloured ones either have covered nests or build in holes in trees.

Returning to sexual colour, the dull summer female plumage which characterises so many ground-breeding birds is all the more remarkable, as they are the mates of males for the most part distinguished by unusual brilliancy. The few exceptions to this rule are of the most interesting nature, and go eminently to prove it. In these exceptions it happens that the female birds are more brightly plumaged than the males. But the remarkable trait comes out that in nearly the whole of the cases the male sits upon the eggs. Now this fact more than any other would seem to indicate that the protection afforded by obscure colouring is directly intended to secure the bird's safety during the long and most critical period of its life.

The law of protective colouring, it will be seen, most influences those species which build on the ground, and one or two examples may be adduced from our own avi-fauna, as in the case of the rare dotterel which breeds on the fells. The only evidence adduced by the late Mr. Gould is that male birds have been frequently shot during the breeding season with the breast bare of feathers, caused by sitting on the eggs. But the shepherds on the Lake mountains not unfrequently kill dotterels on the nest, and these invariably turn out to be males. In the district indicated this species is much persecuted, on account of the valuable "fishing feathers" which its plumage furnishes. In winter the colouring of the sexes is almost identical; but when the breeding season comes round, the female dons a well-defined and comparatively conspicuous plumage, while it is found that the dull-coloured male alone sits upon the eggs.

Mr. Wallace has pointed out that Bee-eaters, Motmots, and Toucans—among the most brilliant of tropical or semi-tropical birds—all build in holes and trees. In each of these cases there is nearly no difference in the plumage of the sexes, and where this is so the above rule is almost invariable. Again, our native kingfisher affords an illustration. Woodpeckers, many of which are coloured above, build in holes in the boles of trees, and our own titmice, with their exquisite tints, build domed nests. Visitors to the Zoological Gardens in Regent's Park will have noticed that the orange-plumaged orioles have pensile nests, which is a characteristic of the order to which they belong, most of the members of which are conspicuous. Bird enemies come from above rather than below, and it will be noticed that the modifications referred to all have reference to the upper plumage. Protective colouring, having for its object the preservation of the species which adopts it, will be found to enter more or less into the economy of every animal and bird and insect in a state of nature; and, therefore, it will be seen that there is a general harmony between the colours of an animal and those of its habitation, of which fact, as already stated, almost every living natural object furnishes evidence.

## THE ECONOMICS OF THE FOG.

By Richard Beynon.

Of all the climatic discomforts to which dwellers in temperate maritime regions are subjected, there are few so irksome, or which cause such destruction to life and property, as fog. The opacity of fog to light is in itself a fruitful source of evil, rendering, as it does, locomotion by land or sea alike dangerous. The dangers at sea have been very materially augmented by false notions as to the acoustic properties of fog. Until twenty years ago it was a generally received opinion that fog deadened sound. This idea was so deeply rooted in the popular mind, that many writers on acoustics accepted the belief as a fact, and invented theories to account for a phenomenon which did not exist.

Humboldt was the first to cast a doubt upon this theory by discovering that a non-homogeneous atmosphere was unfavourable to the transmission of sound; but it was left for Professor Tyndall to show conclusively that fog, instead of retarding sound, really transmits sound with greater freedom than an atmosphere which, though optically clear, may yet be, as far as its acoustic properties are concerned, turbid or flocculent. Fog is merely the visible result of the partial condensation of the aqueous vapour present in the atmosphere, and this act of condensation removes the chief barrier to the transmission of sound, viz., aqueous vapour which often occurs in air in the form of invisible streaks or curtains, which break the continuity of the sound, or in other words, deaden it. These acoustic clouds may occur on days of great optical clearness, and have been known to retard the progress of sound to such an extent as to render unheard at a distance of three or four miles the reports of some forty or fifty field pieces continuously fired during an engagement in the Franco-

Prussian war. The puffs of smoke announcing the discharge of the guns could be distinctly seen, but not a sound reached the observers. On the other hand, the firing at Waterloo was heard at Dover, and a well-authenticated instance is on record of the discharge of the mid-day gun at Portsmouth during a dense fog being audible at Fulham, some forty-four miles away.

The natural imperviousness of fog to rays of light is considerably increased by the presence of soot and smoke. Each globule of condensed vapour forms a nucleus round which the floating particles of carbon cluster themselves. To account for the peculiar density of a London fog another factor must be considered. On all sides save the east London is surrounded by hills. It follows that these hills, with their exposed surfaces, have a superincumbent atmosphere many degrees colder than London, with its millions of inhabitants and its countless chimneys, each emitting its quota of warm air and smoke. The cold air on the tops of these encircling hills will naturally have a tendency to slide down the slope until it comes into contact with the warmer air below. Should the air in the town be on the point of saturation it is obvious that the increased cold will cause a precipitation of moisture, and it would thus happen that a fog of great density would be produced, especially in the neighbourhood of water, as the river Thames and the ornamental pieces of water in the parks.

Any contrivance which will tend to produce more perfect combustion of coal must exert a reducing influence upon the density of our fogs. Economy of fuel and prevention of smoke are as much sought after by the engineers of to-day as the philosopher's stone was by alchymists of old. Though much has been attempted, yet comparatively little has been accomplished in this direction. The testing engineer of the National Smoke Abatement Institution, however, has pronounced in favour of a patent furnace, the principle of which is that known as "underfeeding," the fuel being supplied to the fire from underneath the furnace grate along with a mechanically induced draught. Should this contrivance achieve the results claimed for it, we may hope to see the atmosphere of our large towns considerably purer and clearer, and the fogs of London approximate more closely to the less-dreaded ones experienced elsewhere.

Upon the water the fog retains all its pristine purity, and its grey, uniform mantle forms the mariner's greatest peril. When nearing shore, or another vessel, the sailor has nothing to guide him but his sense of hearing. We have shown above that fog does not retard the transmission of sound, but there is one effect it has upon sound-waves which is almost worse. When a sound-wave produced in a fog strikes the ear it is often almost impossible to locate the source of the sound with any degree of accuracy. The whole surrounding air seems resonant with the sound, making the direction of the source of the sound mere matter of surmise. This was strikingly illustrated during some experiments conducted by the United States Lighthouse Board. While at sea, during a dense fog, the steam-whistle of a ship was distinctly heard. The investigators attempted in vain to localise the sound, differing by four points in their endeavours to fix the position of the neighbouring vessel. Error of judgment in such cases, or miscalculation of the distance of the fog-signal, be it steam-whistle, horn, fog syren, or gun, may be fraught with the most disastrous consequences. Yet since 1874, when the Trinity Board inaugurated a series of experiments under Professor Tyndall, little or nothing has been done to provide our coasts with *adequate* fog-signals.

## THE MOON AS SEEN IN THE LICK TELESCOPE.

By A. C. Ranyard.

I AM indebted to Mr. Burnham for the photographs of the moon from which the accompanying plates have been made, and to Professor Holden, the director of the Lick Observatory, for leave to publish the photographs in Knowledge. The plates have been prepared from silver prints, made from the negatives taken in the principal focus of the great telescope. When it is used for photographic purposes an additional lens is placed in front of the object glass, reducing its aperture to 33 inches, and the focus of the telescope to 550 inches.

It will be noticed that the different photographs are not all of the same diameter; for example, the middle photograph on the first plate is only about $5\frac{1}{8}$ inches in diameter, whilst photograph No. 1 is about $5\frac{1}{2}$ inches in diameter; yet all the photographs have been copied in the same way from the original negatives, and they are nearly exactly the same size as the originals. This difference is due to the moon's varying distance from the earth. If we had a photograph taken when the moon was at its nearest (in perigee) side by side with one taken when the moon is furthest from the earth (in apogee), there would be a difference of nearly three-quarters of an inch on the scale corresponding to the photographic focus of this great telescope, for the apparent diameter of the moon varies from 29′21″ to 33′30″, and its distance from nearly 253,000 miles to about 221,600 miles.

The photographs sent over by Mr. Burnham are exquisitely sharp, and, considering that two photographic copyings are necessary in order to produce the blocks from which the accompanying plates have been printed, the result is very satisfactory; indeed, I think that the plates are the best representations of the moon which have yet been published.

The dark ink in which they are printed brings out in striking contrast the difference of brightness of various parts of the lunar surface. The great planes are mostly very dark compared with the mountains and higher regions. The general brightness or *albedo* of the moon's surface is, according to Zöllner, 0·1736, perfect whiteness being called 1; but there are many parts of the lunar surface which are as white as the whitest terrestrial substances, such as clean snow, the *albedo* of which, according to Zöllner, is only 0·783. The great whiteness of the limb or outer sharp edge of the moon's disc, as compared with the terminator or rough edge, is very noticeable in these as well as in all other photographs of the moon. This narrow band of increased brightness along the limb is noticeable even in photographs of the full moon, where the sun as seen from the limb will either be rising or setting. It cannot therefore be explained as due to the greater altitude of the sun. It is even seen on parts of the limb where the shadows would fall towards the observer, as in photograph No. 3. The increase of brightness is comparatively sudden and sharp, and gives rise to a white line or narrow band of brightness along the edge of the limb. In this region we generally see only the tops of the lunar mountains, the valleys and plains being hidden from us by the higher ground. It seems, therefore, that the higher regions of the moon are decidedly whiter than the lower-lying valleys and plains. Occasionally one of the lunar plains falls near to the limb, as in photograph No. 1, where a small dark plain or lunar sea is to be seen as a narrow grey line near to the middle or westernmost portion of

XUM

1. 2. 3.

PHOTOGRAPHS OF THE MOON TAKEN WITH THE GREAT REFRACTOR OF THE LICK OBSERVATORY, CALIFORNIA.

With this Photographic Lens the aperture is reduced to 33 inches, and the focus to 550 inches.

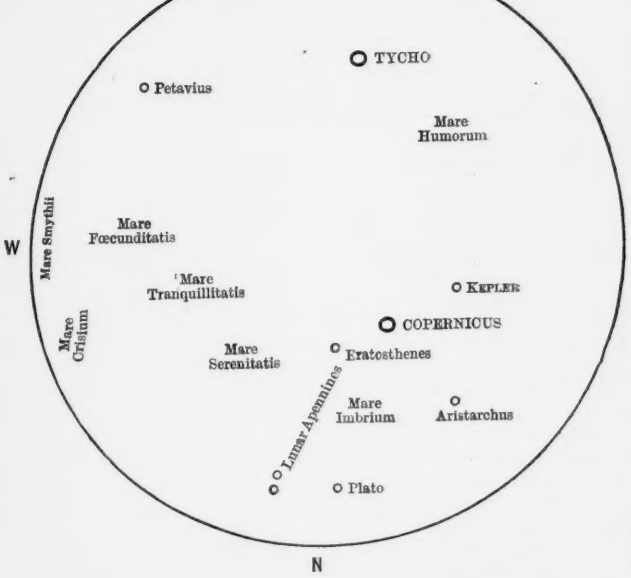
*Direct Photo Eng. Co., Limited, 9, Barnsbury Park, N.*

XUM

XUM

the limb. This plain was known as Kæstner by Schroeter and the older observers, but it has been rechristened the Mare Smythii by an Englishman, after Admiral Smyth, the father of Piazzi Smyth. Such plains, when seen near the lunar limb, appear dark in comparison with the higher ground, and they do not grow brighter as the moon's libration brings them near the limb.

Seen as a whole, the moon appears decidedly grey. Sir John Herschel compared its colour to that of the weathered sandstone rock of Table Mountain. He says, "I have frequently compared the moon setting behind the grey perpendicular façade of the Table Mountain, illuminated by the sun just risen in the opposite quarter of the horizon, when it has been scarcely distinguishable in brightness from the rock in contact with it, the sun and moon being nearly at equal altitudes, and the atmosphere perfectly free from cloud or vapour." This estimate of the moon's general brightness agrees well with Zöllner's measure of the moon's *albedo*. Zöllner gives the *albedo* of white sandstone as




0·237, clay marl 0·156, quartz porphyry as 0·108, and dark grey syenite as 0·078. The whiter parts of the moon must therefore reflect much more light than grey sandstone.

It is usually assumed that there are no snow-caps to the lunar mountains because there is no marked difference in whiteness between the lunar poles and the lunar equator, and because no perceptible change takes place in the whiteness of the equatorial regions during the fortnight of intense sunlight or the fortnight of darkness to which the lunar surface is alternately exposed. Certainly no clouds are ever seen hiding large areas of the lunar surface. I am careful to say large areas because there are some curious changes which take place in the brightness of certain small areas as the sun rises. One of the most notable of these changes is the appearance of long whitish lines or streaks radiating from certain of the lunar mountains, as, for example, from Tycho, Copernicus, Kepler, and Aristarchus. They become visible after the sun has been shining for a day or two upon the lunar surface, and run generally in straight lines, crossing lunar planes and mountains. Some of these great rays are well shown upon the photographs, but they are best seen when the moon is full. The Rev. T. W. Webb says of them that in some cases they proceed from a circular grey border surrounding a crater, in others they cross at its centre. They pass alike over mountain and valley, and even through the rings and cavities of craters. Beer and Mädler thought that they were due to the exhalation of vapour from dykes or faults radiating from volcanic centres. Others have suggested that water vapour issues under the influence of the solar heat along the line of such faults, and is precipitated on either side as hoar-frost or snow; but if such were the case, it is argued that the streaks would continue to grow in distinctness during the whole of the lunar day, and would be seen stretching across the terminator as the sun sets. But their visibility seems entirely to depend upon the sun's altitude, and not on the heated condition of the surface. The rays disappear a day or two before the sun sets much in the same order as they appear after his rising. The fact seems to be that on the lunar terminator differences of level are prominently brought into view by reason of the long shadows cast, and that differences of tint or *albedo* become more and more recognisable as the sun rises and the illumination becomes more brilliant. The streaks seem to correspond to some difference of tint or *albedo* rather than to differences of level, such as one might perhaps expect to find associated with faults and trap-dykes 1,000 and more miles in length.

I am one of those who do not feel sure that the whiteness of the higher parts of the lunar mountains is not due to snow. The fact that no clouds are seen hiding the lunar landscape is not conclusive evidence that there is no water or ice on the moon's surface, for no clouds form in the higher regions of the earth's atmosphere. If the lower ten miles of atmosphere were removed from the earth's surface, it seems probable that the snow-line would descend to the sea level even at the equator, and that no clouds would float above the frozen seas and snow-clad continents. In the course of time, as meteoric débris continued to fall, the snows would lose their virgin whiteness, at all events in the hollows, where the meteoric dust would be carried, forming cryoconite deposits, as they actually are formed in the hollows of the Paleocrystic sea of our polar regions.*

We may feel pretty certain from the level character of the lunar planes and the apparently stratified character of such districts as the lunar Apennines, that there once was abundance of water on the moon's surface. It must either be there now in the form of ice and snow, or it must have been absorbed into the body of the moon—a supposition which I always felt some difficulty in accepting as probable; while the other supposition, that it has entered into chemical composition with the rocks of the lunar surface, seems even more difficult to make unless we suppose that there has been a general reheating of the lunar surface that would have obliterated the traces of water action which are generally admitted to exist.

My chief difficulty in accepting the theory that the moon is covered with ice lay in a series of experiments made by Lord Rosse, with a thermopile in the focus of his 3-foot reflector, which seemed to show that there was a change of temperature amounting to more than 500° Fahrenheit on the moon's surface between lunar midnight and lunar midday, and that the temperature of the lunar midday was considerably above that of boiling water. But a more recent series of experiments by Professor Langley, with very sensitive heat-measuring instruments, assigns a tem-

* See papers by Dr. Walter Flight in the *Geological Magazine* for March and April, 1875, and paper by Dr. Nordenskjold in the Comptes Rendus, lxxvii. 463.

perature to the full moon as low as the freezing temperature of water. The considerations involved are very complicated, and I do not at present feel competent to decide between the two results. But there is another class of consideration which weighs in my mind perhaps more strongly than I shall be able to make evident in a short and elementary paper like the present. There seems to be evidence, that cannot well be rejected, which shows that when large meteorites have fallen sufficiently near to people to be observed as they lie on the ground, or in the hole which they have made, that they have been seen to cool from white to red heat—then to become dark and then snow-white—that is, they become covered with hoar-frost deposited from the moisture in the air, for they afterwards return to the grey or dark natural colour of the stone. This would seem to show that only the outer skin of the meteorite has become heated in the few seconds occupied by its passage through the air, while the interior remains at or near the temperature it had before it entered the earth's atmosphere.

I hope that if any reader of Knowledge should find himself near to a meteorite when it has just fallen that he will place his hand close to it as it cools; he had better not actually touch it, for one may be badly burnt by a cold body as well as by a hot one. Let him make any experiment which the situation permits to determine how much the meteorite falls below the temperature of surrounding objects as it cools. He might spit upon it and note the time when it ceases to frizzle and commences to freeze. There are several instances in which observers have come up to small meteorites within a few minutes of their fall, and in which they have not observed the white hoar-frost; but this may have been due to the small size of the meteorite, and to its passage through the air having been a long one owing to its having followed the earth in its track, or to its having fallen very obliquely through the air so that a thick skin became heated. The meteorite before it enters the atmosphere must have a temperature which will be somewhere between the temperature of its sun-exposed side and its dark side; that is, probably somewhere between the highest and lowest temperatures during the lunar month of the moon's surface. If this is so much below freezing that after having absorbed the heat of the white hot skin large meteorites are still cold enough to cause the moisture of the atmosphere to be thickly deposited upon them as hoar-frost, the mean temperature of the moon's surface is probably very much below freezing-point.

If the lunar snow is not melted by the heat of the midday sun, evaporation would still take place and the aqueous vapour raised in the daytime would be precipitated again during the lunar night. We know so little about the distribution of water vapour in our higher atmosphere, and the reason why clouds do not form there, that we cannot dogmatise as to the formation of cloud and the changes that would take place over a nearly airless snow-field.

I say nearly airless, because it is evident from the phenomena of total solar eclipses and occultations of stars at the moon's limb that there is not a lunar atmosphere which would refract light grazing the lunar limb through five seconds of arc, and that there is not as much air or other gas at the level of the lunar limb as there is at a height of thirty miles above the sea-level in our atmosphere. I make my calculation thus. The horizontal refraction at the sea-level is about 34′. In passing into the atmosphere and out again after grazing the earth's limb, a ray of light would be bent through an angle of 1° 8′. At a height of a little more than three and a half miles* the density of our atmosphere is one-half of its density at the sea-level. At a height of seven miles the density is only one quarter of that at the sea-level, and at a height of a little more than thirty-two miles (neglecting changes due to temperature, &c.), the density would only be $\frac{1}{512}$th of that of the air at the sea-level, and a ray of light passing through the earth's atmosphere at an altitude of thirty-two miles would only be deflected through an angle of a little more than eight seconds of arc. If the atmosphere above this level were taken to the moon's surface, where gravity is about one-sixth of gravity at the earth's surface, it would occupy a column six times as high, and the atmosphere at its base would be one-sixth as dense as when acted upon by terrestrial gravity. Taking the greater curvature of the moon's limb into account, this would give a deflection of a little more than five seconds of arc for a ray passing through such an atmosphere.

* More exactly, 19,570 feet. There is a mistake in my article on "Mountain Observatories" in the April number of Knowledge, I then spoke of the height of the lower half of the atmosphere as 13,050 feet, which is really half the height of an equally heavy column of uniform atmosphere all as dense as the air at the sea-level. I have only just discovered the slip. It is curious that it has not been pointed out to me by any of the sharp eyes which kindly keep watch on Knowledge.

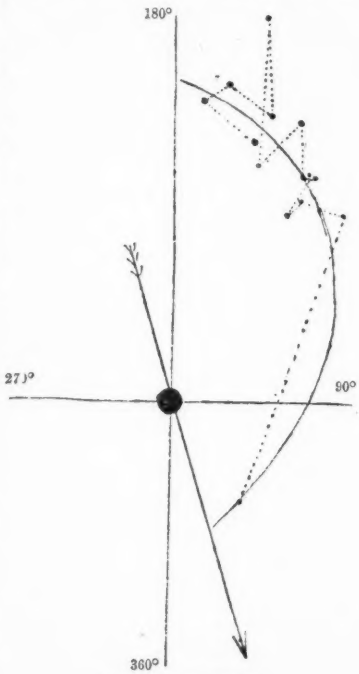
## Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

### τ CYGNI.

*To the Editor of* Knowledge.

Dear Sir,—This star was discovered to be an unequal double by Mr. Alvan G. Clark in October 1874, with the 26-inch object-glass now at the Leander McCormick Observatory. At this time it was comparatively easy with a much smaller aperture. Dembowski measured it on a number of nights in 1875–6, using a refractor of only about seven inches aperture. It was very soon apparent from his measures that there was considerable relative motion, which could not be accounted for by the proper motion of the large star. A little later it became much more difficult to measure from the decrease in distance, and from 1881 to the present year it has appeared to be single, or rather the change in distance has placed it beyond the reach of the largest instruments. I was unable to see it last year with the 36-inch, but this year I obtained



Orbit of τ Cygni.
Scale 1″ = 1·53 inches.

a good set of measures, considering the difficulty of the object. The angular motion since the last preceding measure in 1880 is not less than 100°. Mr. Gore from the measures to 1880 found a period of 58·87 years. Probably the later observations will reduce the error in the provisional orbit arising from the small arc covered by the previous measures.

The following are all the measures to the present time :—

| | | | | |
|---|---|---|---|---|
| 1874·89 | 162·6° | 1·11″ | Newcomb | 2*n* |
| 1875·12 | 174·5° | 1·24″ | Dembowski | 2*n* |
| 1875·69 | 170·5° | 1·32′ | Dembowski | 3*n* |
| 1876·79 | 161·5° | 1·24″ | Dembowski | 2*n* |
| 1876·83 | 166·9° | 1·62″ | Waldo | 2*n* |
| 1876·90 | 160·2° | 1·03″ | Hall | 2*n* |
| 1877·70 | 155·3° | 1·26″ | Dembowski | 8*n* |
| 1878·41 | 150·0° | 1·06″ | Burnham | 1*n* |
| 1878·54 | 147·5° | 1·09″ | Dembowski | 3*n* |
| 1878·76 | 158·8° | 1·09″ | Hall | 2*n* |
| 1879·50 | 148·3° | 0·90″ | Burnham | 2*n* |
| 1879·75 | 147·3° | 0·98″ | Hall | 6*n* |
| 1880·77 | 137·4° | 1·04″ | Hall | 1*n* |
| 1889·49 | 36·5° | 0·50″ | Burnham | 4*n* |

These measures are drawn to scale on the accompanying diagram, the distances and angles being laid down as accurately as possible. Some of the measures are very discordant in the angles as well as the distances. The several positions of the small star are connected by the dotted line in chronological order. The direction of the proper motion of the bright star is indicated by the arrow. This change amounts annually to 0·48″ in the position angle of 17·4°. Evidently this is common to the components.

There is a distant companion preceding, of which the following are all the measures :—

| | | | | |
|---|---|---|---|---|
| 1876·90 | 260·3° | 15·68″ | Hall | 1*n* |
| 1889·32 | 246·7° | 19·33″ | Burnham | 2*n* |

This change is certainly due to proper motion. It is a faint star, and was first seen with the Washington telescope.

The close star is now very difficult, and perhaps beyond the reach of any other telescope in the world. It will probably be soon easier to observe, as the distance should be increasing. This is one of the most interesting of the stellar systems, and should be carefully measured with instruments competent to deal with it.

Lick Observatory: August 29. S. W. Burnham.

*To the Editor of* Knowledge.

Dear Sir,—I did not expect my letter to you criticising Mr. Roberts' photograph would appear in print, as I think, in general, that criticisms of that kind, unless they point out a positive error, are scarcely worth printing, and it is better for each piece of work to stand on its own merits.

In Mr. Roberts' reply, however, p. 211, there is an error committed in the theory of astronomical photography, which should perhaps be pointed out. He argues that because he can photograph fainter stars with twenty inches aperture than we have done with eight, he can therefore photograph fainter nebulæ. It is generally considered that the brightness of a star which can be detected visually by a telescope varies inversely as the square of its aperture, and is within reasonable limits independent of its focus. With photographic telescopes, however, we find that in climates as unsuited to astronomical photography as are those of Cambridge and England, this rule is unfair to the larger instrument, and that the brightness of the star varies more nearly inversely as the square of the aperture, multiplied by the time and divided by the focus. That is, the shorter the focus the fainter the star. This is because the star is constantly moving about upon the plate, owing to atmospheric distortions, and accordingly with the long focus lens the image covers a larger area than it does with the other.

In the case in point we have the following constants for the two instruments :—

| Name. | Apertures. | Foci. | Exposures. |
|---|---|---|---|
| Roberts | 20 | 100 | 205 |
| Harvard | 8 | 45 | 90 |

Applying this modified rule to a comparison of the two telescopes, we have the light

$$\frac{L}{l}=\frac{A^2\times T\times f}{a^2\times t\times F}=\frac{400\times 205\times 45}{64\times 90\times 100}=6\cdot4.$$

When we come to photographing surfaces, however, the conditions are quite changed, and our formula becomes $\frac{L}{l}=\frac{A^2\times T\times f^2}{a^2\times t\times F^2}=2\cdot9$. Mr. Roberts should, therefore, be able to photograph a star of $\frac{1}{6\cdot4}$ the brilliance, with this aperture and exposure, while he would only photograph a surface of $\frac{1}{2\cdot9}$ the brightness.* It is, therefore, quite possible that under certain circumstances he should photograph fainter stars than we, and yet not be able to photograph as faint surfaces.

Now as to the facts. Mr. Roberts refers to "a noticeable light patch to the north following up M 43, which looks like, and has possibly been, assumed by Professor Pickering to be a nebulosity joining the two nebulæ." As this same light patch appears on three separate negatives, taken respectively February 6, 9, and 13, 1888, I think Mr. Roberts is mistaken in saying that because it does not appear upon his negative, it is therefore a photographic stain. Besides this broad nebulous patch, there are also a number of fainter fine streaks and rays, joining the two nebulæ, to the north preceding M 43, whose details accurately correspond upon the three negatives above mentioned.—Respectfully yours,

Harvard Col. Observatory. Wm. H. Pickering.

[I am sorry that I mistook Professor Pickering's private letter for one intended for publication. I do not entirely agree with his exposition of the difference in photographic efficiency of a large and small telescope for photographing stellar points and luminous areas. The diameter of the spurious disc which represents a stellar point in the principal focus of a telescope varies inversely as the aperture of the telescope and directly as the focal length, consequently the brightness of the stellar disc varies as

$$(\text{Aperture})^2\times\left(\frac{\text{aperture}}{\text{focal length}}\right)^2.$$

Atmospheric disturbances will cause the centre of the disc to swing over an arc upon the plate which is directly proportional to the focal length, and if the stellar disc which registers itself on the plate is very small compared with the arc swung over, the photographic efficiency will vary as $\frac{A^4\times T}{F^4}$ nearly. We find that with the best telescopes the photographic patch representing even a small star is many times larger than the star disc visible to the eye in the telescope, and many times larger than the first bright ring. According to Dawes, the diameter of the star disc visible in an optically perfect 20-inch telescope is 0·228 seconds, but in Mr. Roberts' photographs of the Orion nebula, the diameter of the smallest star discs photographed certainly exceeds 5 seconds.

In the case of the smallest stars photographed, the

* Both these numbers must, of course, be multiplied by a constant dependent on the instrument, locality, plates, &c.

photographic action must be due to the central and brighter parts of the spurious disc which would impress itself first on the plate. With longer exposures the outer parts of the spurious disc, the bright rings, and the illuminated field, due to the optical imperfections of the instrument, successively register themselves, till with a large star we have a patch sometimes two minutes of arc in diameter.

The diameter of the small patches representing the smallest stars photographed gives a rough measure of the average atmospheric disturbance during the exposure,* and the diameter of the large patches produced by the bright stars gives a measure of the optical imperfection of the photographic instrument used. Comparing the photographic efficiency of Mr. Roberts' and Professor Pickering's instruments for small stars, we get

$$\frac{A^4 \times T. \times f^4}{a^4 \times t \times F^4} = \frac{160000 \times 205 \times (45)^4}{8^4 \times 90 \times (100)^4} = 3{\cdot}65,$$

and for photographing luminous areas

$$\frac{A^2 \times T \times f^2}{a^2 \times t \times F^2} = 2{\cdot}88.$$

The fact that the disc and rings vary inversely as the aperture and directly as the focal length will be made evident to those who are not familiar with the subject by the accompanying diagram. Let AB be the main wave front entering the telescope, every part of the ether in motion will give rise to secondary waves spreading right and left of the perpendicular direction. Let us take any inclination CD, draw AW and Cw perpendicular to CD. Then, if Bw is equal to half a wave length, the secondary waves from A1, 12, 23, and 3C will be half a wave length in advance of, and will destroy those from C5, 56, 67, and 7B respectively, and consequently the direction CD will correspond to the first dark ring, the angle subtended by the dark ring, as seen from the centre of the object glass, will evidently be independent of the focal length, and the diameter of the ring will vary with the focal length, and inversely as AB, the aperture.

The angular diameter of the star discs and rays, seen in a telescope when an eyepiece is used, is independent of the focal length, because the longer the focus of the telescope the less the focal image requires magnifying to give any required power.—A. C. Ranyard.]

* Possibly the patch of photographic action produced by a very small star does not correspond in diameter to the whole of the swing of the star image on the plate; the spurious disc crosses the central parts of the patch as it dances on either side of its mean position more frequently than it passes over any of the outer parts of the initial photographic patch. This would, if the motion were uniform, give rise to an increase in density towards the centre of the patch, but though the edges of the patches corresponding to small stars are soft, there is not a very marked increase of density towards their centres. If there is any analogy in the swing of a star image to the swing of a pendulum, it would move more slowly towards the ends of its swing, and sweep swiftly over its mean position. We get such a swing when a telescope vibrates, and in some photographs of total eclipses, when the instrument has been shaken by the wind, the plate has shown a double image of the prominences corresponding to the ends of the swing. Probably the dance of the star disc on the photographic plate has but little analogy to the swing of a pendulum except in so far as it is produced by small tremors of the instrument.

## NOTE ON RECURRING DECIMALS.

*To the Editor of* Knowledge.

Dear Sir,—The following remarkable property of the power of a recurring decimal is worth noticing:—

$(\cdot\dot{1})^2 = \left(\frac{1}{9}\right)^2 = \cdot\dot{0}12345679\dot{9}$, a period consisting of nine figures, having all the digits except 8, and these in ascending order.

$(\cdot\dot{0}\dot{1})^2 = \left(\frac{1}{99}\right)^2 = \cdot\dot{0}0010203 \ldots 969799\dot{9}$, a period consisting of 2 $(10^2-1)$, or 198 figures, in pairs ascending to 99, with the exception of 98, which is absent.

$(\cdot\dot{0}0\dot{1})^2 = \left(\frac{1}{999}\right)^2 = \dot{0}00\ 001\ 002 \ldots 997\ 999\dot{9}$, having 3 $(10^3-1)$, or 2997 figures, and 998 absent.

This, of course, can be easily generalised.

A simple proof of the first part in any scale is here added:—

Let

$$P = \cdot\dot{0}123 \ldots (r-3)(r-1),\ r \text{ being the radix.}$$

$$\therefore rP = \cdot\dot{1}234 \ldots (r-1)\dot{0},$$

$$\therefore P(r-1 = \cdot\dot{1}) \text{ by subtracting}$$

$$P(r-1) = \frac{1}{r-1},$$

$$P = \frac{1}{(r-1)^2} = (\cdot\dot{1})^2.$$

Yours faithfully, R. Chartres.

[I have received several letters this month with regard to the theory of number question referred to in Mr. T. B. Russell's letter. I may, perhaps, find room for some of them in a future number.—A. C. R.]

## DOES THE FEMALE VIPER SWALLOW ITS YOUNG FOR THEIR PROTECTION?

*To the Editor of* Knowledge.

Sir,—Unfortunately the common adder (or viper) when in captivity is usually a very sullen reptile, and I am afraid that it would give the naturalist but little opportunity for observing its maternal affection, even if a female with young should be obtained without injuriously disturbing or killing the mother. I have kept adders several times, and now have two healthy pairs; but although I once succeeded in taming a male adder, I have never succeeded in making a female forget that it was a prisoner. Amongst vipers the females are certainly more sulky and bad-tempered than the males, so that the question will always remain an open one if we must wait until we see the young swallowed by their mothers in captivity. My illustration showing the adder with its fangs erect (referred to by Pen-y-Pan) is quite correct. Two fangs are erected when the adder prepares to strike—no more. The other teeth are merely in readiness should one or both the fangs be lost. The largest adder I have seen was three feet four inches in length.—Yours truly,

A. J. Field.

[Dr. William Duncan, in a recently published paper on the "Fer-de-lance," one of the *Crotalidæ*, or Pit Vipers of the West Indian Islands, says that the female Fer-de-lance devours her young in very wholesale fashion. This dangerous serpent is very prolific, and sometimes brings forth as many as 200 young at a birth, seldom less than 100. Dr. Duncan says the female Fer-de-lance, when about to bring forth her young, "generally selects a fairly open or cleared space, a mountain footpath being a favourite spot. Along this she crawls slowly, dropping her young one by one on the way. As soon as the last has been brought forth, the faint and hungry mother turns and devours the first of her brood that meets her sight, and continues this unnatural

XUM

XUM

4. 5.

PHOTOGRAPHS OF THE MOON TAKEN WITH THE GREAT REFRACTOR OF THE LICK OBSERVATORY.

*Direct Photo Eng. Co., Limited, 9, Barnsbury Park, N.*

course until satiated with her repast, or she finds no more of her offspring to glut her rapacity. Naturally many of them, three-fourths at least, escape, and these the strongest—a clear case of the survival of the fittest. This has been observed by several planters in St. Lucia, and has been mentioned to me independently by Mr. E. S. Gordon, Mr. A. R. Marucheau, and Mr. Marius Devaux, and others of the colony."—A. C. R.]

## DOGS AND BEARS, IN THE PRESENT AND THE PAST.

By R. Lydekker, B.A. (Cantab.).

COMPARATIVELY few animals belonging to a single sub-order are more unlike one another, both as regards external as well as internal characters, than the bears and the dogs, their dissimilarity being indeed so marked, that not even the most unscientific person experiences the slightest difficulty in distinguishing between the two groups. The former group, as is well known, comprises a comparatively small number of species, among which the European brown bear, the closely allied Syrian bear, and the Isabelline bear of the Himalaya, the North American grizzly bear, the Indian sloth bear, and the Polar bear are typical examples, which are usually well represented in the living state in the gardens of the Zoological Society, and whose skeletons and stuffed skins may be seen in the Natural History Museum at South Kensington. In the latter, and far more numerous group, are included the wild and domestic dogs, the wolves, jackals, foxes, and fennecs, together with some less typical forms, which need not be further alluded to on this occasion.

So wide, indeed, is the gap between these two groups, that naturalists have not only placed them in distinct families, but have even brigaded the family of the bears together with that of the weasels, badgers, otters, &c., and that of the racoons, in a common section to which they have given the name of the arctoid or bear-like animals, while they rank the dogs in another section of equivalent value, to which the name of the canoid, or dog-like animals is applied. That this division is a perfectly natural one so far as regards the animals existing at the present day there is no doubt; but when our investigations are carried back to the consideration of the varied forms of carnivorous animals whose remains occur in the rocks of the tertiary or latest geological period of the earth's history, it has been found that animals then existed which so completely bridge over this gap that there appear to be no distinctive characters by which the bears and the dogs can be separated from one another. It will of course be apparent to the reader that when we have to determine the mutual relations of extinct fossil animals we have to depend solely upon the structure of their bones and teeth, and can therefore say nothing as to the appearance of these old-world forms when clothed with flesh and fur. Fortunately, however, in the present, as in many other instances, the bare bones and teeth are amply sufficient to give us a very fair idea of the relationship of the fossil to the living forms, although the ardent palæontologist cannot but help wishing that he had the power of casting a glance on those long-past periods when our earth was comparatively young and inhabited by the marvellous host of extinct animals whose modern descendants have so woefully diminished both in size and numbers.

Making, however, the best of our opportunities, and not wasting time in futile regrets at being unable to recall that which has passed away for ever, we may, before proceeding to the consideration of the fossil forms, briefly contrast a few of the more striking features in the organisation of a dog (under which term it will be convenient to include wolves, jackals, foxes, *et hoc genus omne*) with those of a bear, as in all such investigations it is advisable to make ourselves thoroughly acquainted with the well-known before we attempt the consideration of the comparatively unknown.

A dog, in this general sense, is characterised externally by his comparatively slight and slender build, long limbs, well-developed tail, and above all by the circumstance that he walks only on his toes—or, as naturalists say, is digitigrade—his wrist and heel being carried far above the ground. The figure of the jackal gives a good idea of the external form of the dogs. A bear, on the contrary, is of an exceedingly bulky and clumsy build (as is shown in fig. 2), has short and thick limbs, a mere apology for a tail, and in walking applies the whole length of his foot to the ground, or, in other words, is plantigrade. It will be unnecessary here to enter into the consideration of the well marked differences in the structure of the soft internal parts of these animals, or, indeed, of the greater part of the skeleton, and we may therefore, in the main, confine our attention to those of the skull and teeth, which, as being the parts more commonly preserved in the fossil state, demand the especial consideration of the palæontologist. There is, however, an important point in regard to the bones of the fore-limb of carnivores which cannot be passed over, namely, that in the arm-bone or humerus of the cat tribe and some extinct dog-like species the lower end is perforated by a small hole, which is totally wanting in the corresponding bone of the dog and bear.

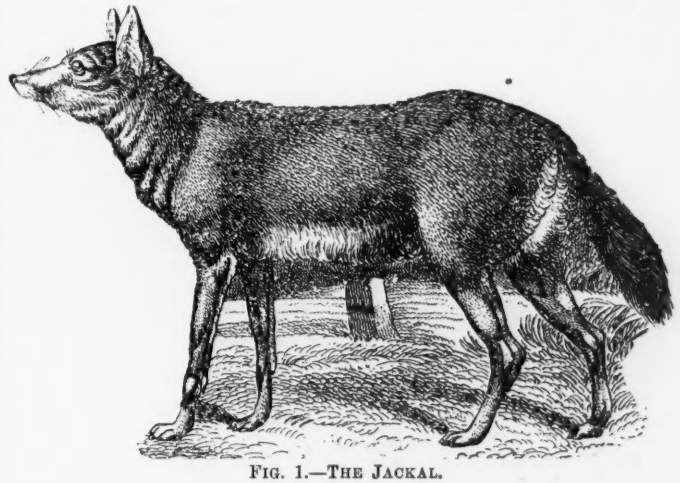


Fig. 1.—The Jackal.

The skull of a dog conforms to the general structure of the whole animal in its light and graceful shape, and is characterised (among many other features) by the presence of a bladderlike bone, covering the under part of the internal ear, which is scientifically known as the "bulla." The solid bony roof of the palate does not extend farther

back than the last tooth, and the teeth are arranged in a gracefully curved line. There are altogether eleven teeth on each side of the upper and twelve in the lower jaw, the first three being called the cutting teeth, the fourth the eye tooth, which is readily distinguished by its tall crown, the

Fig. 2.—The Brown Norwegian Bear.
(From Jardine.)

next four the false grinders, and the remainder (two in the upper and three in the lower jaw) the true grinders. The most important features of these teeth are that the last two in the upper jaw are triangular in shape (as is shown in the woodcut), the hinder being much smaller than the preceding one, and that they are mainly adapted for crushing, although they have an imperfect cutting-edge on their outer side; while the third tooth from the hinder end of the jaw, which is termed the "flesh-tooth," is longer than either of the other two, and has a much higher crown, with

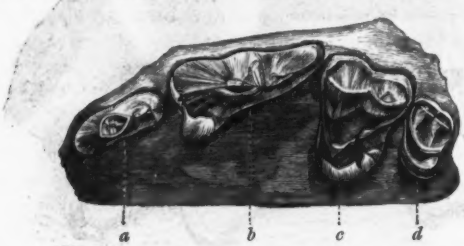



Fig. 3.—The Last Four Left Upper Teeth of a Wolf. *a*, false grinder; *b*, flesh-tooth; *c*, first grinder; *d*, second do.

a sharp cutting-edge, which bites with a scissor-like action against the similarly elongated and high-crowned "flesh tooth" of the lower jaw. This type of tooth structure indicates an animal whose diet consists mainly of animal substances.

Turning now to the bear's skull, we see that it is altogether of a stouter and more massive type, while the bladder-like "bulla," which we noticed in the dog, is altogether wanting, and is replaced by a nearly flat bony plate, while the bony roof of the palate extends considerably behind the last tooth, the teeth themselves being arranged in a nearly straight line. In young animals there is the same number of teeth as in the dog; but in the adult the second and third false-grinders are frequently shed. The hinder teeth, however, differ very widely from those of the dog, the two last in the upper jaw being rhomboidal instead of triangular in shape, and having still flatter crowns, while the last is the larger (instead of the smaller), and is very much elongated. The upper "flesh-tooth" shows this contrast still more markedly, for instead of having its crown both longer and taller than those of the two hinder grinders, it is very much shorter, with a crown not higher, and lacking the sharp cutting-blade found in the corresponding tooth of the dog. In the teeth of the lower jaw very similar differences may be observed, the crown of the "flesh-tooth" being no higher than that of the succeeding tooth, while its length is only equal to that of the latter, instead of exceeding it by twice its own length. The "eye-teeth" have, moreover, relatively lower crowns than those of the dog. It is of course obvious that the broad flat crowns of the hinder grinding-teeth of the bear are adapted to a vegetable or mixed, rather than to a purely flesh diet; and it is noteworthy that in the Polar bear, which subsists to a large extent on fish and putrid seal- or whale-flesh, there is a tendency to a rather greater development of the cusps of its hinder teeth than in its congeners, whose food consists to a great extent of vegetable or soft animal substances. In the Indian sloth-bear, on the other hand, which feeds largely upon honey, insects, &c., the teeth are reduced to a very small size in proportion to the dimensions of the skull.

If now we carry ourselves back in imagination to a period in the earth's history, which although comparatively late from a geological point of view, yet is very early indeed from a human one, we find evidence of the existence in northern India, as well as in several parts of Europe, of a huge bear-like animal, which has received the somewhat inappropriate name of the hyæna-bear (in scientific language *Hyænarctus*). This creature lived in India at a time when the Himalaya was but a comparatively low chain of hills, and ages before England was separated from the Continent, in a period which is termed by geologists the Pliocene. Now if we ask ourselves in what respects this bear-like creature differed from any modern bear, we must answer that while its skull and limb-bones have the massive and bulky characters of existing bears, yet we find certain features showing that we are at least one step away from these modern specialised types. Thus, to take one instance from the limbs, the bone forming the elbow has an extremely prominent termination, or "funny-bone," and in this respect resembles the dogs and differs from the bears. The teeth, however, show us in a much more unmistakable manner what a marked approach this animal makes to the dogs. Thus, the "flesh-tooth" in both jaws has a long and cutting crown totally unlike that of the bears, and of the same structure as in the dogs, although of a rather more complex type than in any existing species. Moreover, the two grinders of the upper jaw, instead of having long oblong crowns, have nearly square crowns in most species, while in one very peculiar species from India they tend to assume the triangular form of the dog's grinders. In the small species, of which the upper grinders are shown in the woodcut, the crowns are longer than usual. The hyæna-bear, which rivalled in bulk the huge American grizzly, was, therefore, to all intents and purposes a bear with a most decided evidence of its relationship to the dogs shown in the structure of his teeth; and we may thus be justified in assuming that this terrible animal was largely carnivorous in its habits. Closely akin to this hyæna-bear is another huge animal from the

Fig. 4.—The Two Left Upper Grinders of a Bear (*Hyænarctus minutus*).

uppermost tertiary of South America, in which it is said that the bone of the arm retains the perforation now found in the cats, and thus gives us one more clue to the descent of the bear.

Taking one more step back in time to the middle division, or *moyen âge* of the tertiary period, technically known as the Miocene epoch, we meet with a creature which unfortunately has no English name, and which we must therefore be content to recognise under the designation of the Dinocyon. This animal was of the size of a bear, but had teeth like those of a dog, although it was in all probability plantigrade, and it had a perforated arm-bone. Here, then, we have at length reached an animal where our definition of a dog and a bear begins to fail us, in spite of the "stretching" we have given these definitions when discussing the hyæna-bear. Yet one step still further back—to the lower part of the Miocene and the upper part of the preceding or Eocene epoch—the dawn of the tertiary period—and we find an animal, the so-called Amphicyon, in regard to which it appears to be impossible to say whether it partakes most of the nature of a dog or of a bear. The best known species of the amphicyon was of the approximate dimensions of a wolf. It had teeth precisely like those of a dog, with the exception that there were three in place of two grinders in the upper jaw, and the general build was also dog-like, with a perforation in the lower end of the arm-bone. The skull, however, has not the bladder-like "bulla" of the dogs, but the flattened ear-plate of the bears, while the animal applied the whole soles of its feet to the ground in walking after the old-fashioned plantigrade manner, and made no attempt to assume the more advanced digitigrade progression of the dogs.

Here, then, it is evident that we have to do with an animal that is quite as much a dog as a bear, being, in fact, a veritable "missing-link;" and consequently a source of sad trouble to those systematists who wish to assign every creature to a fixed place in their cut-and-dried schemes. Thus we find that while the learned Director of the Natural History Museum regards this troublesome amphicyon as a plantigrade dog, and consequently places it among the canoid animals; other writers consider it as a dog-toothed bear, and refer it to the arctoid group. The truth is, however, that we must recognise in this early carnivore the common ancestor from which both bears and dogs have taken their origin, and have thence tended more and more to diverge from one another with the advance of time, till they finally have assumed their present extreme differences, which, as we have already observed, are apparent to the most unscientifically disposed mind. Accepting this convergence of the two groups as a proved fact, we must therefore regard the separation of the dogs and bears into two distinct families as merely a convenient classification for their existing representatives, and not as a real primary division.

The interest of the amphicyon does not, however, end with its relationship to the bears and dogs, since it also shows evident signs of cousinship with other lower Miocene and upper Eocene carnivorous animals, which appear to connect the dogs with the civets, and thus with the hyænas and cats. One of these early connecting types is known as the dog-civet (*Cynodictis*), and appears to be an animal closely allied both to the amphicyon and to the true civets; so that we have good evidence for regarding both bears, dogs, and civets as having originated from a common stock more or less closely allied to our amphicyon. Since, moreover, the hyænas and cats (under which name we include lions, tigers, and their allies) are evidently derived from a stock more or less nearly related to the earlier civets, we are enabled to trace back all these wonderfully different types of carnivorous animals to a very few ancestral stocks.

A like pedigree has been already traced out in many other groups of animals, and as our knowledge (imperfect as it must necessarily always remain) gradually increases by slow, although we hope sure, steps, we shall look forward to do the same for other groups, till we find the whole of the animals of the present day forming the twigs of one huge ancestral trunk.

## ON SOME PRINTERS' PRANKS.

By the late R. A. Proctor.

ALTHOUGH many authors owe more to compositors than they imagine, especially in the matter of punctuation, yet sometimes compositors play strange tricks with an author's meaning. In the very first proof I ever corrected (for a book, at least) I found a most absurd change in a quotation I had made from Chaucer. It was in the opening pages of my treatise on "Saturn and His System." I had quoted the well-known passage in the "Knight's Tale," in which Chaucer presents Saturn, curiously divided between Saturn the god and Saturn the planet, explaining to his "dere doughter Venus," that his "course which hath so wide for to turne, hath more power than wot any man"; Saturn mentions among other unpleasant phenomena over which he has influence, "the drowning on the durke cote"—that is, on the dark coast. The printers altered this into "the drowning in the dirty coat," which is not poetical.

But of misprints, wilful or otherwise, which have come under my own notice, none has seemed to me more amusing than the following:—In the little work on "Spectroscopic Analysis," which I wrote for the Society for Promoting Christian Knowledge, I had occasion to mention in a note on the last page certain "lines, bands, and striæ, near the violet end of spectra": this appeared in type as a remarkable statement respecting "links, bonds, and stripes, for the violent kind of spectres"—creatures of whose habits I am entirely ignorant.

The subtlest way in which the compositor will alter the meaning of an author is by the misplacement, misuse, or disuse of a comma. The change is often so subtle that in correcting proofs the author overlooks it. The words still run smoothly enough; and, intent on corrections of verbal or literal mistakes, the author does not notice a change of meaning which, though brought about by a very slight error in composing, may alter sense into nonsense. It is only when the book is published and the author is turning over its pages, that he finds one of these sentences committing him to some strange and startling opinion.

For instance, I was made once to state that the stars are blue or green in tint, and seldom visible except with a telescope. What I wrote was simply "The stars which shine with a blue or green tint are mostly telescopic;" what the punctiliously punctuating printer made me say was: "The stars, which shine with a blue or green tint, are mostly telescopic."

Mr. Herbert Spencer was in like manner made to assert that the reason why whales are not fish is that they possess fins and a fish-like tail. What he wrote was—"Whales are not fish because they possess fins and a fish-like tail"; but the printers made the philosopher of the Unknown say that "Whales are not fish, because," &c.—a most remarkable reason. The passage still stands thus in Spencer's collected Essays.

Mr. Archibald Geikie, desiring to explain that the Auvergne volcanoes look as if they were not extinct (though

they have been so for ages), wrote as follows: "The volcanoes of Auvergne are as fresh as if they had not yet ceased to be active and might break out again at any moment." By inserting a comma after "active," the compositor has committed Mr. Geikie to the statement that these volcanoes might at any moment resume their activity.

I am very sorry to see coming into vogue in American printing a bad practice which was tried for awhile in England but presently abandoned as tending to confusion. (All authors of the least acumen recognised the system as illogical.) I refer to the practice of omitting the comma after the last but one of three nouns or verbs when the last is preceded by "and,"—writing, for instance, "Mary, James and John" instead of "Mary, James, and John." The most notable work which suffered from the employment of this illogical punctuation, was Macaulay's "History of England," and very strange indeed were some of the things which Macaulay was made to say by the omission of commas in this particular way. I have a collection of about a score of sentences of his, some of which convey meanings definitely erroneous, like those mentioned above, while the rest convey two distinct meanings, one only of which is correct, and that the one which the reader is least likely (apart from the context) to select. One can well understand the story of Macaulay's wrath when he first saw the printed volumes in which this essentially incorrect method of punctuation was employed—though for aught I know the story may be wholly apocryphal.

A sufficient reason for leaving the comma in this case, is that every careful reader makes the "commatic pause" (as Lord Grimthorpe calls it) before the "and" preceding the final noun; so that to remove the comma is to bring the punctuation out of accord with the reading. When we read such a sentence as this, "King, lords, and commons stood by each other," we never think of making less pause between the words "lords" and "and" than between the words "king" and "lords." Let the reader try the effect, and he will see that to make no commatic pause after "lords" is to bring the words "lords and commons" into a closer connection than there is between the words "king" and "lords," an effect which the sense will not warrant. On the other hand, in the sentence "Both houses of Parliament, Lords and Commons, stood by each other," the comma is omitted after "Lords" precisely because the words "Lords and Commons" are to be connected together. Observe, then, a double mischief in the usage I am opposing. In one case, the omission of the comma conveys a wrong impression: but in the other case, where the comma should be omitted, its omission still leads to a false impression if the wrong usage has fairly come into vogue: in this case there is absolutely no way (except a clumsy use of parentheses) of expressing just what we want. How shall an American printer who has been taught to follow this vicious and illogical method, express the essentially American idea conveyed in the sentence "Congress, Senators and Representatives, must with united voice resist encroachments on this nation's liberty": if the usage coming into vogue is definitely adopted, this sentence as it stands is sheer nonsense, for it begins by mentioning three distinct nouns—(1) Congress, (2) Senators, and (3) Representatives—which is absurd.

In a spirit-stirring passage, an American novelist makes an American captain command his crew to board the enemy, calling for "Boarders, greybeards and boys, idlers and all." If the absurd new usage had been adopted when Cooper thus wrote, Captain Barnstable would have been made to call for boarders and for greybeards and for boys, and for idlers, &c., instead of enjoining his crew that *all* were to join in the attack; they were *all* for the nonce to be boarders.

That the commatic pause should precede the "and" where the nouns really are distinct, will be seen by any one who compares the way in which he would read the words, "Then came Mary his mother, with James and John, Peter and Andrew, and others of the disciples," and these, "Then came Mary his mother, with Peter, James, and John."

The fact that the meaning of conjoined names varies according as the comma is used or omitted, is another sufficient reason—a stronger reason, though—for using the comma or omitting it, according as one meaning or another is intended. This applies even in cases where there can be no doubt as to the writer's meaning. When Mr. Howells says of one of his heroes (I do not refer to any of his young men, who are without exception to my mind the meanest persons ever presented as heroes of fiction), that he had "an honest, fair and square face," the reader is not likely, even though the printer had omitted the comma after the second noun-adjective of three really independent, to imagine that Silas Lapham's face was honest and fair and also square. But it is a mere accident that in such a case there can be no mistake.

Here is a case where the shades of meaning depending on the use or omission of the comma are different, yet not so different but that correct punctuation is necessary to show which meaning is intended:—Suppose (if one can imagine such a horror) we had an edition of Shakespeare punctuated according to the false system I am dealing with, then the line (York's speech, 2nd Part of Henry VI., Act 3, Scene 1),

> "Say he be taken, racked and tortured,"

would have to be understood as distinguishing "racking" from "torturing," whereas when correct punctuation is followed throughout, the words "racked and tortured" are taken together, a reading obviously more effective than the other: in fact the former, implying that racking is not torturing, is absurd; the latter which presents racking as a part of the torturing is very striking. Then comes in (in this case) the question of rhythm. Compare the reading of the two lines—

> (1) "Say he be taken, racked, and tortured,"
> (2) "Say he be taken, racked and tortured":

it will be seen at once that the pause after "taken" in (2), a pause absolutely essential to the second sense, makes the line much more effective than (1). It corresponds with what might in prose be written thus, "Say he be taken; say even he be racked and tortured." The context shows that this was intended. In the folio there is a semicolon after tortured, and this seems an improvement; but there is a comma after "racked" showing that the actors who prepared that edition had not caught the correct idea in regard to this passage. [It is a matter of perfect indifference to my argument which usage is accepted as best; because all I contend for is that the use or disuse of the comma after the second noun—substantive or adjective—gives a different meaning: the false system I am objecting to is based on the idea that the omission of the comma does not alter the sense.]

Shakespeare would be disastrously injured if this illogical usage came into vogue. How it would be with the Bible may be shown by a hundred passages—but I prefer to take one which involves no religious dogma, so far as I can judge. In the third verse of the first chapter of Exodus are these words: "Reuben, Simeon, Levi, and Judah; Issachar, Zebulun, and Benjamin; Dan, and Napthali, Gad, and Asher." It may be safely inferred that there was some reason for distributing the sons of Jacob thus into sets of four, three, and two pairs. Our new punctuators would alter the passage into, "Reuben, Simeon, Levi and Judah;

Issachar, Zebulun and Benjamin; Dan and Naphtali, Gad and Asher"—which would either imply (if a logical interpretation were adopted, that Levi and Judah were somehow paired to represent Simeon, while Zebulun and Benjamin were paired to represent Issachar; *or*, if the false system is accepted as sound, the passage would imply that Dan was to be left alone, not coupled with Naphtali as the Jewish writer meant him to be; while Naphtali, Gad, and Asher, were to form a triplet which that Jewish writer had not imagined. I have already cited two cases in which American writers would suffer from the wrong usage. Here is another. Bret Harte in his "Office Seeker," says that Gashwiler was very heavy, very unwieldy, very unctuous and oppressive. If the new usage were in vogue, the words "unctuous" and "oppressive" could no longer be regarded as paired, which they are meant to be.

Printers must not by punctuation pranks run the risk of making many Bible passages doubtful, which are now clear. Nor must Shakespeare suffer injury, or American writers be made to appear absurd in the eyes of their compatriots. As for science, many perhaps will not care so much; but I must confess I should be sorry to see scientific writing confused by false punctuation. The astronomer who wrote "The inferior planets, Mercury and Venus," would seem if the new punctuation were adopted, to mean that Mercury and Venus were other bodies than inferior planets; the geologist who wrote the "felspars, zeolites, and mica" if this was printed without a comma after "zeolites," would seem to those who have logical ideas about punctuation, to mean that zeolites and mica are felspars. And so in a number of such cases.

Religion, then, literature, and science, alike demand that printers should be taught the absurdity of this illogical system of punctuation. Even the fact that they save a comma in a page or so does not counterbalance the fact that they often make nonsense of a writer's meaning—whether in Bible, book, or scientific treatise.

## THE FACE OF THE SKY FOR OCTOBER.

By Herbert Sadler, F.R.A.S.

SUNSPOTS are appearing much more frequently now than for some time past; the faculæ, too, are unusually bright and large. Conveniently observable minima of Algol occur on the 9th at 9h. 21m. P.M., on the 12th at 6h. 10m. P.M., and on the 29th at 11h. 4m. P.M. The fine variable star *o* Ceti can still be observed, as, though the predicted maximum occurred on August 6, the star remains visible to the naked eye for two months and a half after it has attained its greatest brilliancy. Mercury is not well situated for observation during the first three weeks of the month, coming as he does into inferior conjunction with the sun at midnight on the 15th, but after this his position rapidly improves, and he may not improbably be detected with the naked eye in the morning twilight at the end of the month. He attains his greatest western elongation ($18\frac{1}{2}^\circ$) on the 31st. On the 22nd he rises at 5h. 26m. A.M., or 1h. 14m. before sunrise, having a southern declination of 5° 56′, and an apparent diameter of 8·6″. On the 30th he rises at 4h. 56m. A.M., or just two hours before the sun, with a southern declination of 5° 43′, and an apparent diameter of 6·8″. At about 5h. on the morning of the 27th, he will be only $4\frac{1}{2}'$ *s.p.* the $4\frac{1}{2}$ magnitude star Θ Virginis. Venus is a morning star, rising on the 1st at 2h. 50m. A.M. with a northern declination of 10° 28′, and an apparent diameter of $12\frac{1}{2}''$; rather more than $\frac{8}{10}$ths of the disc is illuminated. At 1 P.M. on the afternoon of that day Venus and Mars are in conjunction, Venus being 22′ south. On the 31st she rises at 4h. 3m. A.M. with a southern declination of 3° 14′, and an apparent diameter of $11\frac{1}{2}''$. On the morning of the 18th she will be about $\frac{3}{4}^\circ$ *n.f.* of *β* Virginis. Mars is a morning star throughout the month, rising on the 1st at 2h. 49m. A.M., and on the 31st at 2h. 36m. A.M., but as his angular diameter only subtends 5″ at the end of the month, he is not an object of any telescopic interest to the amateur observer. Jupiter is an evening star, and is rapidly approaching the west, and should be looked for as soon after sunset as possible. He sets on the 1st at 9h. 12m. P.M, with a southern declination of 23° 30′, and an apparent diameter of $37\frac{1}{2}''$. On the 31st he sets at 7h. 34m. P.M., three hours after sunset, with a southern declination of 23° 28′, and an apparent diameter of $34\frac{1}{2}''$. On the evening of the 6th he is 12′ due south of a $5\frac{1}{2}$ magnitude star in Sagittarius (Lacaille, 7613), which is of a reddish colour. The following phenomena of the satellites occur between the times of the planet's being 8° above the horizon, and the sun's being 8° below, on the days named. On the 4th a reappearance from occultation of the 3rd satellite at 7h. 31m. On the 6th an occultation (disappearance) of the second satellite at 6h. 29m. On the 7th a transit ingress of the first satellite at 7h. 29m. On the 8th an egress from transit of the shadow of the second satellite at 6h. 36m. On the 15th a transit ingress of the shadow of the second satellite at 6h. 27m.; an egress from transit of the satellite itself at 6h. 40m.; an egress of the shadow of the third satellite from transit at 6h. 42m.; and an occultation (disappearance) of the first satellite at 6h. 43m. On the 16th an egress from transit of the first satellite at 6h. 14m. On the 22nd an egress from transit of the third satellite at 5h. 56m. On the 23rd a transit-ingress of the first satellite at 5h. 56m. On the 24th an eclipse (reappearance) of the second satellite at 6h. 22m. 37s., and a reappearance from occultation of the fourth satellite at 6h. 25m. Saturn is a morning star, in Leo throughout the month. He rises on the 1st at 2h. 16m. A.M., with a northern declination of 12° 51′, and an apparent diameter of 15″. On the 31st he rises at 0h. 34m. A.M., with a northern declination of 11° 57′, and an apparent diameter of $15\frac{1}{2}''$. He describes a short path in Leo to the SE. of Regulus. Uranus is in conjunction with the sun on the 15th. Neptune is in Taurus, and rises on the 1st at 7h. 38m., with a northern declination of 19° 22′, and an apparent diameter of $2\frac{1}{2}''$. On the 31st he rises at 5h. 38m. P.M., having moved slowly westward during the month. He is situated about midway between the stars ω (Omega) and 43 Tauri. October is rather a favourable month for observations of shooting stars, the most marked shower being that of the Orionids, from the 17th to the 20th of the month, the radiant point of which is situated in VIh. O.R.A. +15° declination. The radiant point rises at the date named at about 8h. 45m. P.M., and sinks shortly after 4h. A.M. The moon enters her first quarter at 1h. 33m. A.M. on the 2nd, is full at 1h. 26m. A.M. on the 9th, enters her last quarter at 0h. 37m. A.M. on the 17th, is new at 2h. 26m. P.M. on the 24th, and enters her first quarter at 8h. 31m. A.M. on the 31st. On the 1st the 6th magnitude star 24 Sagittarii will disappear at 9h. 8m. P.M. at an angle of 110° from the vertex, and reappear at 10h. 11m. at an angle of 322° from the vertex, but the moon will then be below the horizon of Greenwich. At 5h. 14m. P.M. on the 3rd the 6th magnitude star B.A.C. 7049 will disappear at 5h. 14m. P.M. at an angle of 40° from the vertex, and reappear at 6h. 13m. P.M. at an angle of 303° from the vertex. On the 5th at 8h. 40m. P.M. the 6th magnitude star 56 Aquarii will disappear at an angle of 143° from the vertex, and reappear at

XUM

9h. 40m. P.M. at an angle of 261° from the vertex. On the 7th the 6th magnitude star B.A.C. 17 will disappear at 5h. 48m. P.M. at an angle of 86° from the vertex, and reappear at 6h. 49m. P.M. at an angle of 249° from the vertex. On the 10th the 6th magnitude star B.A.C. 830 will disappear at 9h. 1m. P.M. at an angle of 124° from the vertex, and reappear at 9h. 45m. P.M. at an angle of 215° from the vertex. On the 13th the 5½ magnitude star *l*, 106, Tauri will disappear at 7h. 10m. P.M. at an angle of 90° from the vertex, and reappear at 7h. 59m. P.M. at an angle of 232° from the vertex. The moon will be below the horizon of Greenwich at the time of disappearance. On the 14th there will be a near approach of the 6th magnitude star 141 Tauri at 8h. 56m. P.M. at an angle of 155° from the vertex. On the 15th at 0h. 3m. A.M. the 6½ magnitude star B.A.C. 1970 will disappear at an angle of 10° from the vertex, and reappear at an angle of 291° from the vertex at 0h. 48m. A.M. The 3½ magnitude star $\eta$ Geminorum will disappear the same morning at 3h. 4m. at an angle of 50° from the vertex, and reappear at 4h. 21m. at an angle of 297° from the vertex. $\eta$ Geminorum is a very unequal close double star, the companion being only of the 9th magnitude, and distant from the large star 1″. On the 16th at 2h. 14m. A.M. the 6½ magnitude star 44 Geminorum will disappear at an angle of 15° from the vertex, and reappear at 3h. 13m. A.M. at an angle of 282° from the vertex. At 0h. 36m. A.M. on the 17th the 6½ magnitude star 84 Geminorum will make a near approach at 139° from the vertex; at 10h. 59m. P.M. the same day the 6th magnitude star 39 Cancri will make a near approach at 322° from the vertex, followed two minutes later by 40 Cancri at the same angle. On the 28th the 6th magnitude star B.A.C. 6161 will make a near approach at 6h. 46m. P.M. at an angle of 208° from the vertex. On the 29th, at 6h. 31m. P.M., the 6th magnitude star B.A.C. 6576 will disappear at an angle of 120° from the vertex, and reappear at 7h. 41m. P.M. at an angle of 299° from the vertex.

## Whist Column.

By W. Montagu Gattie.

### THE DISCARD.

THERE are few matters as to which a beginner is more often perplexed than when, being void of the suit led, he has to choose a card of some other suit to throw away on the trick. In the earliest days of his novitiate, it may seem to him that one small card will in most cases answer the purpose as well as another; but he very soon learns not only that an improper selection may seriously damage his own hand, but also that his discard is a means of affording valuable information to an attentive partner, and may induce him to modify or entirely alter his conduct of the game. Conversely, it is of the first importance to notice the discards — especially the original discards — of both partner and opponents, and to omit this duty is much more culpable, and will, in the long run, prove more disastrous, than to overlook a call for trumps.

Ordinarily speaking, the rules for discarding are not at all hard to master; but situations of considerable difficulty sometimes arise, especially towards the end of a hand, and ingenuity in "forcing a discard" at the right moment is one of the distinguishing marks of a strong player.

When a player is unable to follow suit, the general rule is, as everyone knows, that he should first discard from the suit in which he is weakest; and, in the absence of previous indications, he informs his partner in this way that whatever strength he has lies in one or both of the two remaining suits. This is a very simple rule, and is in consonance with the leading principle of playing to establish a long suit and to bring it in after the trumps are out. Of course, no one would, under ordinary circumstances, carry the rule so far as to unguard a king or blank an ace; but, subject to particular exceptions such as these, the discard from the weakest suit was, until a comparatively recent date, considered to be a maxim almost as inviolable as the original lead from the strongest suit.

Some fifteen or twenty years ago, however, whist players began to awake to the fact that many rubbers were lost by a too rigid adherence to this method of play, and eventually several enthusiasts determined to make it the subject of a careful experimental inquiry. It is clear that when the adversaries have great strength in trumps there is not much chance of making the long cards in a plain suit, although these may, of course, become very useful in forcing out the trumps. It is, on the other hand, frequently of the utmost consequence in such a case to be well protected in the other plain suits, so as to hinder the enemy as long as possible from establishing either of them. These considerations cannot have been overlooked previously; but it was no doubt regarded as essential that a uniform system of discarding should be observed, since any departure from it could not fail, under the convention then existing, to deceive one's partner. The result of the inquiry to which we have referred was published by "Cavendish" in *The Field*, and took shape in the following canon:—"*When you see from the fall of the cards that there is no probability of bringing in your own or your partner's suit, discard originally from your best-protected suit.*"

Theoretically this modification of the old-fashioned rule is quite unimpeachable. But it is open to the practical objection that the degree of probability, or possibility, of bringing in a suit is not seldom a matter of considerable doubt, and moreover one as to which a player and his partner may very well hold widely different views. Now there is one way above all others in which a player can indicate his intention of playing a strong game, and that is by leading or calling for trumps. It follows, therefore, that when an adversary leads or calls for trumps, it may *primâ facie* be assumed that he has a good hand, and that defensive tactics will be prudent. And thus, as the difficulties surrounding the application of the new rule came to be appreciated, many players adopted a less scientific but much more simple convention, viz., "*Discard originally from your best-protected* (*i.e.*, *strongest*) *suit when the adversaries lead or call for trumps.*" Here we have a canon as to which there can be no difference of opinion, and if it be strictly observed no one can ever be in any perplexity as to whether his partner's discard was from strength or weakness.

But to this rough-and-ready system there are also serious objections—more serious, in the opinion of many competent judges, than those which arise from the uncertainty attaching to the application of the more exact rule of play. "Cavendish" remarks, in his treatise, that it is "a very imperfect and misleading aphorism," and he gives two illustrations of his meaning, which we shall now reproduce.

1. Z deals and turns up nine of clubs. A (the original leader) leads a small club, Y follows suit, B puts on ace, Z plays king. This shows that Z has a sequence of queen, knave, ten, nine, of trumps; and therefore that, although A has led a trump, he has anything but the command of the suit. B returns the trump; Z wins; Y has no more trumps. His discard should be from his weakest suit.

2. A leads a tierce major in trumps, eleven trumps come

out, and Y must have the knave of trumps to save the game. Z now credits his partner (Y) with the command of trumps, though the adversary has led them; and, if either Y or Z has to discard, the discard should be from the weakest suit.

As regards case No. 1, we are not quite clear that Z's play of the king of trumps is correct. It is true that it informs Y where the intermediate trumps are, but this is also information of great value to A and B, who have the lead, and who may take the hint to play a more backward game. A has probably led from five small trumps, and if B has one to return, Y is most likely void. If Z plays king on ace, B may hesitate to return the trump lead; but he will certainly return it if Z plays the nine, and Z will win the second round with the ten, drawing two trumps to one and giving his partner ample indication where the honours lie. Setting aside this point, there can be no question that Y should in such a case discard from his weakest suit; and it is equally certain that he should adopt this course, notwithstanding an adverse lead of trumps or "call," when he himself has great strength in trumps, or when his partner has "called," or when the adverse lead is clearly from weakness. In order to meet these and similar cases, our convention has been modified thus: "*Discard originally from your best-protected suit when trumps are declared against you.*" But here again there is room for uncertainty; and when uncertainty arises we believe that an average player, or indeed a good player, cannot do better than follow the less accurate but quite unmistakable rule, which we venture to say will in ninety-nine cases out of a hundred be a sufficient guide. The second illustration given by "Cavendish" is a case in point. Theoretically speaking, the discard from the weakest suit may be correct. But it must be remembered that the discard is of primary importance as an agent for conveying information, and that all doubt as to its meaning should, if possible, be eliminated. One cannot always play whist with the same partner, or with a partner of whom one can predicate confidently what view he may take of the game at any particular stage. We confess that, for our own part, we would rather play with a man who informs us at the outset that he always discards from his strong suit in the presence of an adverse trump lead, than with one who, by continually drawing nice distinctions, however accurate, might often perplex us as to whether he were discarding from strength or weakness.

In the case before us Y and Z are playing a losing game, and can scarcely be looking forward to establishing a long suit. It is, on the other hand, of the utmost importance that they should each know what winning cards the other holds, and any misunderstanding on this point will probably be fatal. Suppose that Z, playing on scientific principles, discards from weakness on the third round of trumps. In order for Y to draw a correct inference from Z's play, he must *assume* that Z has *assumed* that he has the knave of trumps. How many players whom we know can be trusted to play by the light of assumptions of assumptions? On the other hand, two moderate players, each following the rule of discarding from strength against a trump lead, would have no difficulty in fathoming each other's intentions. There remains one other point upon which a word has to be said. If Y and Z, having eventually the command of the trump suit, ought to discard from their weak suits, is it right also that A and B should adopt a corresponding change of tactics, and, although they have led trumps originally, proceed to discard from strength? Few whist-players, we imagine, would answer this question in the affirmative; and yet it is difficult to see how any other answer would be logically consistent with the doctrine laid down for the guidance of Y and Z.

We shall give next month a hand exemplifying the importance of the discard as a means of information.

## Chess Column.

By I. Gunsberg (Mephisto).

[Contributions of general interest to chess-players are invited. Mr. Gunsberg will be pleased to give his opinion on any matter submitted for his decision.]

THE following remarkable game was played at the Amsterdam Tournament between Van Vliet and Lasker. In eccentricity of attack it resembles somewhat the Vienna game of Steinitz and Winawer. White won, and Lasker missed his chance for first prize. Black would have won the game by a move suggested in analytical notes by Dr. Hunt.

| White. Van Vliet. | Black. Lasker. |
|---|---|
| 1. P to K4 | 1. P to K4 |
| 2. Kt to KB3 | 2. P to Q3 |

The nature of this defence is well known, and has been often commented. If I desired to play a close game, as second player I should never choose the Philidor. Black, however (unfortunately for himself), had received an inspiration from another player to try the effect of a peculiar continuation, by which he gives up a Pawn in order to gain a speedy development.

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| 3. P to Q4 | 3. B to Kt5 |
| 4. P × P | 4. Kt to Q2 |

The loss of the Pawn is compensated for to some extent by a rapid development, which might be turned to good account by a sharp and attacking player castling on the Queen's side. Its soundness has, however, yet to be proved.

| | |
|---|---|
| 5. P × P | 5. B × P |
| 6. B to K2 | 6. KKt to B3 |

I should have played Q to K2 here, as that move gives the option of castling QR.

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|---|---|
| 7. Kt to B3 | 7. Q to K2 |
| 8. Kt to Q2 | 8. P to KR4 |

Now that White has hampered his Queen's side by Kt to Q2 this move is effective; it makes White's castling KR dangerous.

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|---|---|
| 9. P to B3 | 9. B to K3 |
| 10. Kt to Kt5 | 10. B to K4 |
| 11. P to B3 | 11. R to R3 |

This move is not objectionable, although at first sight it appears premature. If White plays 11. Kt to B4, Black replies with 12. B × Kt, and if 12. B × R, 13. B × B. But, on general principles, it would have been better to castle QR before entering on such speculations.

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|---|---|
| 12. Kt to Q4 | 12. R to Kt3 |
| 13. Kt × B | 13. R × P |

Black seems to have been carried away by a very keen instinct. This risky move might have led to a win, as will be shown, if properly followed up. But Black did not see the proper continuation, and his play is stigmatised as wild and unreasonable by most critics, and yet how near he was to producing one of the most remarkable games on record if he had seen the right move. Truly an apt illustration of the sublime and the ridiculous almost touching each other. My reflections carry me, however, further still.

Supposing Black would have seen the way to win. All the world would have called his play sublime. I would have differed, although I might not perhaps care to put myself openly in opposition to the general opinion. For it is clear by the course of this game that Black entered upon this line of play, not knowing the result, and risking the loss of the game. That is simply bad play; at least I may say losing play, which is the same, and which cannot by the mere accidental discovery of a brilliant way to win, or by any other successful issue, be turned into good play; and most so-called brilliant games which I have seen have given me the impression that the brilliancy was a matter of accident, and ought not to excuse the losing play which led up to it as it might have done in this game.

14. B to Bsq,

Black was evidently playing against the man and not against the board, which is not a good policy to adopt, especially against a stranger, who may be underrated, as in this instance. For White certainly defends himself with coolness; B to Bsq looks all right, but really gives Black an opportunity for a brilliant continuation. Instead of this move, White might have played K to Bsq without having much to fear in consequence.

14. R × P

There Black misses his chance. It seems inexplicable how Black could have overlooked the effect of Kt × KtP, followed by Kt to B5 defending everything. Sheer desperation ought to have shown Black the right move, which, as before mentioned, would have led to a good, if not a winning game—viz. 14. Kt to Kt5 threatening mate. White's only defence is 15. B × R. Then follows Q to B5 (ch). 16. K to K2, Q to B7 (ch). 17. K to Q3, Kt to B4 (ch). 18. Kt × Kt, R to Qsq (ch). 19. K to B2, Kt to K6 (ch). 20. K to Kt3, Kt × Q. 21. R × Kt, Q × B, and Black has a good game, as he will capture the KRP and have a passed Pawn, and he will also, by playing Q to K7, prevent the development of White's pieces. Apart from this simple course which is forced, Black has also other opportunities, though less sure than the preceding line of play, *i.e.* Kt to Kt5. 15. B × R, Q to R5 (ch). 16. K to K2, Q to B7 (ch). 17. K to Q3. Now Kt to K6 leads to some very interesting play. Black threatens mate by Kt to B4 (ch) and R to Qsq. White, therefore, has no better move than 18. Q to R4. If Black now plays P × Kt, White replies with 19. R to Bsq. A better continuation is probably 18. P to QB3, again threatening mate by Kt to B4 (ch) and R to Qsq. Our readers will find plenty of amusement in following up this move and endeavour to find out whether Black could have won. After P to QB3 a pretty mate can be got out of B to B5, followed by Kt to K4 (ch) and Kt to Kt5 mate.

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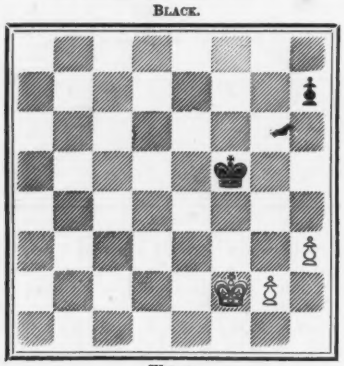
|---|---|
| 15. R × R | 15. B × R |
| 16. Kt × KtP (ch) | 16. K to Bsq |
| 17. Kt to B5 | 17. Q to K4 |
| 18. Q to K2 | 18. Kt to Kt3 |
| 19. Q to Kt2 | 19. Kt(B3)Q4 |
| 20. Kt to B4 | 20. Kt × Kt |
| 21. B to R6 (ch) | 21. K to Ksq |
| 22. Q to Kt8 (ch) | 22. K to Q2 |
| 23. Q × P (ch) | 23. K to Bsq |
| 24. Castles | Resigns. |

Credit is due to White for the soundness of his play after he obtained an advantage.

## END-GAME STUDY.

R. L. O'Beirne writes to us asking that we should show him how White can win in the following position:—

Black.



White.

White to move and win.

On examination we find that there are three points in this position. One is that Black's only chance is not to move his Rook's Pawn, as otherwise White will drive the King from the Pawn in the well-known fashion, *i.e.* 1. K to B3, P to R4. 2. P to Kt3 (forcing the opposition) K to K4. 3. K to K3, K to B4. 4. K to Q4 K to B3. 5. K to K4, K to K3. 6. K to B4, K to B3. 7. P to R4, K to Kt3. 8. K to K5, K to Kt2. 9. K to B5, K to R3. 10. K to B6, K to R2. 11. K to Kt5 and White wins. The process is much the same if the Pawn moves to R3 now or later, but care must be taken not to lose the opposition. The Pawns must only in this case be moved to regain the opposition. A little practice at this kind of play will be very useful to our readers, even to the experienced ones.

The second point in this position is that White can leave his own Pawns, and that Black cannot go after the white Pawns, *i.e.*:—1. K to B3, K to Kt4. 2. K to K4, K to R5. 3. K to B4, K to R4 4. K to B5, K to R5. 5. K to B6, K to Kt6. 6. K to Kt7, K × P. 7. P to R4, K to R3. 8. P to R5, and wins. As showing the care and the nicety of play which is required to win, I add the following variation:—1. K to B3, K to Kt4. 2. K to K4, K to R5. 3. K to B5 (?), K to Kt6. 4. K to B6, K × P. 5 P to R4, K to B6 (this move draws, any other move loses). 6. P to R5, K to K5. 7. P to R6, K to Q4. 8. K to Kt7, K to K3. 9. K × P, K to B2 draws.

The third point is that White must endeavour to reach the square on R6 with his King without having moved his Knight's Pawn (unless the Black Pawn is moved as before) for reasons which I shall explain presently.

1. K to B3, K to Kt4. 2. K to K4, K to Kt3. 3. K to B4, K to B3. 4. K to Kt4, K to Kt3. 5. P to R4, K to R3. (If Black plays P to R4(ch) instead, we have the first variation, White replying 6. K to B4, K to B3. 7. P to Kt3 forcing the opposition.) 6. K to B5, K to Kt2. (If Black plays instead K to R4, White replies with P to Kt3, and the position is the same as in the second variation.) 7. K to Kt5. Now comes the crux of the problem. Black can play either K to Rsq. or Kt sq. If the White Knight's Pawn were on Kt3, Black would draw by K to Kt sq., if on Kt4 he would draw by K to Rsq.; but being on Kt2, White has the option of advancing either 1 or 2 so as to gain a move upon Black and arrive on Kt7 at the moment when the Black King is on Kt sq. and win, *i.e.*, if K to Rsq. 8. K to R6, K to Ktsq. 9. P to R5, K to Bsq. 10. P to Kt4, K to Kt sq. 11. P to Kt5, K to Rsq. 12. P to Kt6, P × P. 13. P × P, K to Kt sq. 14. P to Kt7, and wins. But if on the seventh move Black plays K to Kt sq., White must only advance his Pawn one square, *i.e.*, 7. K to Kt sq. 8. K to R6, K to Rsq. 9. P to R5, K to Kt sq. 10. P to Kt3, K to Rsq. 11. P to Kt4, K to Kt sq. 12. P to Kt5, K to Rsq. 12. P to Kt6, P × P. 13. P × P, K to Kt sq. 14. P to Kt7, and wins before. To show the reverse: supposing 7. K to Kt sq. 8. K to R6, K to Rsq. 9. P to R5, K to Kt sq. 10. P to Kt4, K to Rsq. 11. P to Kt5, K to Kt sq. 12. P to Kt6, P × P. 13. P × P, K to Rsq. and the game is drawn.

Sam Parry.—The right move is 3. Kt to B3.

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